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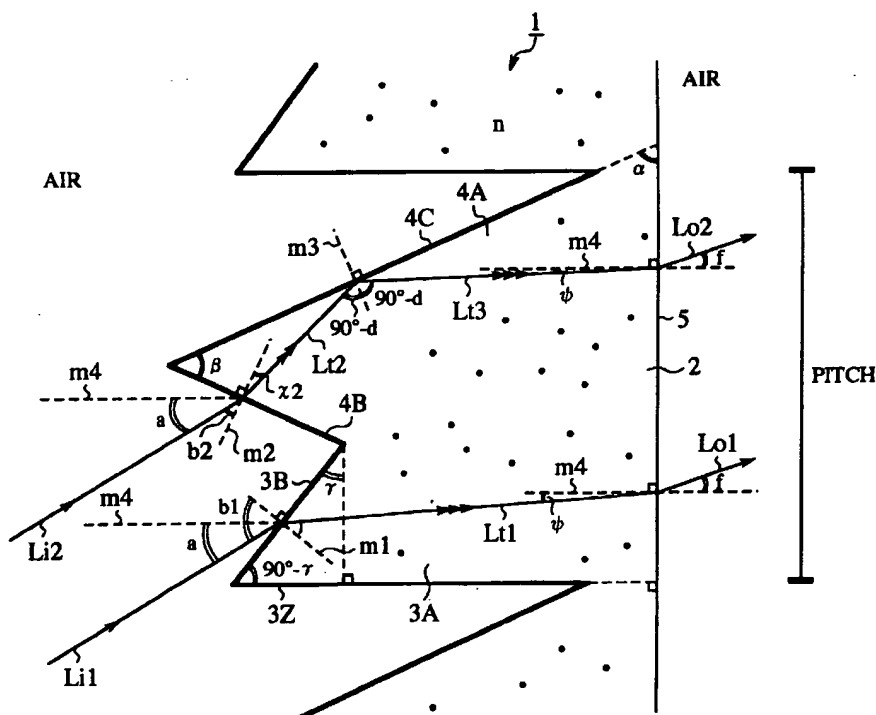
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(54) Titre : LENTILLE DE FRESNEL, ECRAN, DISPOSITIF D'AFFICHAGE D'IMAGE, PROCEDE DE FABRICATION DE MOULES POUR LENTILLES ET PROCEDE DE FABRICATION DE LENTILLES

(54) Title: FRESNEL LENS, SCREEN, IMAGE DISPLAY DEVICE, LENS MOLD MANUFACTURING METHOD, AND LENS MANUFACTURING METHOD



(57) **Abrégé/Abstract:**

A Fresnel lens has a pitch including a hybrid prism comprising a refraction prism unit (3A) for emitting an incident light (li1) of an incident angle (a) as an outgoing light (lo1) of an outgoing angle (f) by two refractions, and a total reflection prism unit (4A) for emitting an incident light (li2) of an incident angle (a) as an outgoing light (lo2) parallel to the outgoing light (lo1) by a refraction, a total reflection, and a refraction.

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ABSTRACT OF THE DISCLOSURE

A Fresnel lens has a plurality of pitch areas in which a plurality of hybrid type prism portions are arranged. Each hybrid type prism portion has a refraction type prism portion and a total reflection type prism portion. In the refraction type prism portion, a ray of incident light L_{i1} of an incident angle "a" is refracted twice and goes out as a ray of outgoing light L_{o1} of an outgoing angle "f". In the total reflection type prism portion, a ray of incident light L_{i2} of the incident angle "a" is refracted, totally reflected and refracted in that order and goes out as a ray of outgoing light L_{o2} parallel to the ray of outgoing light L_{o1} .

WHAT IS CLAIMED IS:

1. A Fresnel lens, comprising:

a pitch area having a hybrid type prism portion which has both
a refraction type prism portion for making a ray of first incident
5 light having a prescribed incident angle go out according to a first
refraction phenomenon and a second refraction phenomenon as a ray of
first outgoing light having a prescribed outgoing angle; and

a total reflection prism portion for making a ray of second incident
light having the prescribed incident angle go out according to a third
10 refraction phenomenon, a total reflection phenomenon and a fourth
refraction phenomenon as a ray of second outgoing light parallel to
the ray of first outgoing light.

2. A Fresnel lens according to claim 1, further comprising another
15 pitch area having the hybrid type prism portion or a plurality of other
pitch areas having the hybrid type prism portions respectively,
wherein a ratio of an area occupied by the refraction type prism portion
to an area occupied by the hybrid type prism portion in each pitch
area differs from ratios in the other pitch areas.

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3. A Fresnel lens, in which a ray of incident light having a prescribed
incident angle goes out through a prism portion as a ray of outgoing
light having a prescribed outgoing angle for each pitch area,
comprising:

25 a plurality of pitch areas respectively having a hybrid type prism
portion which has both a refraction type prism portion and a total
reflection prism portion integrally formed with each other, wherein
a sectional shape of the refraction type prism portion of each pitch
area is formed by:

30 a first incident plane for changing a ray of first incident light

incident at a prescribed incident angle to a ray of first transmitted light according to a first refraction phenomenon;

a plane-shaped outgoing plane for changing the ray of first transmitted light obtained on the first incident plane to a ray of first outgoing light having a prescribed outgoing angle according to
5 a second refraction phenomenon; and

an ineffective plane connecting with the first incident plane and an adjacent pitch area,
a sectional shape of the total reflection type prism portion of each
10 pitch area is formed by:

a second incident plane for changing a ray of second incident light incident at the prescribed incident angle to a ray of second transmitted light according to a third refraction phenomenon;

a total reflection plane for changing the ray of second transmitted
15 light obtained on the second incident plane to a ray of third transmitted light parallel to the ray of first transmitted light according to a total reflection phenomenon; and

the outgoing plane of the refraction type prism portion,
the ray of third transmitted light obtained in the total reflection
20 plane is changed to a ray of second outgoing light having the prescribed outgoing angle according to a fourth refraction phenomenon on the outgoing plane, and

a portion of the ray of second incident light not changed to the ray of third transmitted light is received as the ray of first incident
25 light.

4. A Fresnel lens according to claim 3, wherein the second incident plane of each pitch area is formed in a sectional shape so as to make the second incident plane conceal the ineffective plane of the hybrid
30 type prism portion arranged in an adjacent pitch from a view seen in

a direction of a ray of ineffective light incident on the ineffective plane, and the total reflection plane of each pitch area is formed in a second incident plane compensating shape so as to compensate for the sectional shape of the second incident plane.

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5. A Fresnel lens according to claim 3, wherein a small incident angle region is determined according to a characteristic changing angle at which transmissivity of the hybrid type prism portion is equal to that of the refraction type prism portion, and the refraction type prism portion is arranged in each of pitch areas placed in the small incident angle region.

15

6. A Fresnel lens according to claim 4, wherein a small incident angle region is determined according to a characteristic changing angle at which transmissivity of the hybrid type prism portion is equal to that of the refraction type prism portion, and the refraction type prism portion is arranged in each of pitch areas placed in the small incident angle region.

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7. A Fresnel lens according to claim 5, wherein a mixing ratio of the refraction type prism portion to the hybrid type prism portion is increased with the decrease of the incident angle in each of pitch areas corresponding to a characteristic changing region neighboring to the characteristic changing angle.

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8. A Fresnel lens according to claim 6, wherein a mixing ratio of the refraction type prism portion to the hybrid type prism portion is increased with the decrease of the incident angle in each of pitch areas corresponding to a characteristic changing region neighboring to the characteristic changing angle.

30

9. A Fresnel lens according to claim 5, wherein an intermediary prism portion is arranged as one hybrid type prism portion in each of pitch areas corresponding to a characteristic changing region neighboring to the characteristic changing angle, an area of the second incident plane of the intermediary prism portion is slightly decreased with the decrease of the incident angle, and an area of the first incident plane of the intermediary prism portion is slightly increased with the decrease of the incident angle.

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10. A Fresnel lens according to claim 6, wherein an intermediary prism portion is arranged as one hybrid type prism portion in each of pitch areas corresponding to a characteristic changing region neighboring to the characteristic changing angle, an area of the second incident plane of the intermediary prism portion is slightly decreased with the decrease of the incident angle, and an area of the first incident plane of the intermediary prism portion is slightly increased with the decrease of the incident angle.

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11. A Fresnel lens according to claim 3, wherein a top blade angle between the second incident plane and the total reflection plane is set to a most-acute angle in a range in which an angle between the second incident plane and the outgoing plane is not obtuse.

25

12. A Fresnel lens according to claim 11, wherein the top blade angle is set to an angle larger than the most-acute angle in a small incident angle region corresponding to incident angles smaller than a specific incident angle at which transmissivity corresponding to the top blade angle set to the most-acute angle is equal to transmissivity

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corresponding to the top blade angle different from the most-acute

angle.

13. A Fresnel lens according to claim 3, wherein the prescribed
outgoing angle is set to a value larger than zero degree in each of
5 pitch areas corresponding to incident angles at which transmissivity
of the hybrid type prism portions is decreased.

14. A Fresnel lens according to claim 3, wherein the Fresnel lens
is cut out in a rectangular shape so as to have four sides, a boundary
10 ring band of the Fresnel lens intersects only one side nearest to an
optical axis among the four sides of the Fresnel lens, the outgoing
angle is set so as to make the ray of first outgoing light and the
ray of second outgoing light going out on a lens periphery side of
the boundary ring band be parallel to the optical axis, and the outgoing
15 angle of the ray of first outgoing light and the ray of second outgoing
light going out on an optical axis side of the boundary ring band is
set to a value larger than that corresponding to the ray of first
outgoing light and the ray of second outgoing light going out in
parallel to the optical axis.

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15. A Fresnel lens according to claim 3, wherein each refraction type
prism portion has a thin-film light absorbing layer on the ineffective
layer, and the thin-film light absorbing layer absorbs light.

25 16. A Fresnel lens according to claim 3, further comprising:
a stray light absorbing plate which is arranged on the outgoing plane
and has a plurality of light transmitting layers and a plurality of
light absorbing layers alternately layered almost in parallel to an
optical axis of the Fresnel lens, wherein a ray of light is transmitted
30 through each light transmitting layer, and light is absorbed in each

light absorbing layer.

17. A Fresnel lens according to claim 16, wherein the stray light absorbing plate arranged on the outgoing plane is integrally formed
5 with the Fresnel lens.

18. A Fresnel lens according to claim 16, wherein the light transmitting layers and the light absorbing layers are layered in a concentric circular shape while centering around the optical axis of
10 the Fresnel lens.

19. A Fresnel lens according to claim 16, wherein the light transmitting layers and the light absorbing layers are layered in a direction almost in parallel to each other.
15

20. A Fresnel lens according to claim 3, further comprising:
a light absorbing plate, arranged on the outgoing layer, for absorbing light.

20 21. A Fresnel lens according to claim 3, wherein the hybrid type prism portions are formed while having a pitch margin between each pair of pitch areas adjacent to each other.

22. A Fresnel lens according to claim 3, further comprising:
25 a group of pitch areas in which a plurality of dummy prism portions are successively arranged, wherein a height of each dummy prism portion in an optical axis direction is set not to have relation to the reception of light.

30 23. A screen, comprising:

the Fresnel lens according to one of claims 1 to 22; and
an image forming and diffusing means for receiving the ray of outgoing light, to which display contents are added, from the Fresnel lens, forming an image from the ray of outgoing light and diffusing the image.

5

24. A screen according to claim 23, wherein the image forming and diffusing means is arranged on the outgoing plane to be integrally formed with the Fresnel lens.

10 25. An image displaying device, comprising:

the screen according to claim 23 or 24;

illumination light source means for emitting a plurality of rays of light almost parallel to each other;

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converging optics means for converging the rays of light emitted from the illumination light source means;

optical modulating means for spatially changing intensities of the rays of light converged by the converging optics means so as to modulate the rays of light according to the display contents; and

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projection optics means for projecting the rays of light modulated by the optical modulating means onto the screen.

26. A Fresnel lens, comprising:

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a plurality of total reflection type prism portions which are arranged on a light incident side and respectively have both a second incident plane, on which a plurality of rays of light are incident, and a total reflection plane on which a part of the rays of light are totally reflected and are deflected in a desired direction, wherein each total reflection type prism portion has a subsidiary unit-prism portion arranged in a part of the second incident plane

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on which a ray of light expected not to be totally reflected on the

total reflection plane is incident, and
the subsidiary unit-prism portion functions as a refraction type prism
portion having a first incident plane on which the ray of incident
light is refracted to be deflected in the desired direction.

5

27. A Fresnel lens according to claim 26, wherein a plane obtained
by extending the first incident plane of each subsidiary unit-prism
portion is placed in a position shifted from the total reflection plane
toward a light outgoing side in a range of the corresponding total
10 reflection type prism portion.

15

28. A Fresnel lens according to claim 26, wherein a ratio of each
subsidiary unit-prism portion to the corresponding second incident
plane differs from those of the other subsidiary unit-prism portions.

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29. A Fresnel lens according to claim 27, wherein a ratio of each
subsidiary unit-prism portion to the corresponding second incident
plane differs from those of the other subsidiary unit-prism portions.

25

30. A Fresnel lens, comprising:

a plurality of refraction type prism portions which are arranged
on a light incident side and respectively have both a first incident
plane, on which a ray of incident light is refracted to be deflected
in a desired direction, and an ineffective plane different from the
25 first incident plane,

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wherein each refraction type prism portion has a subsidiary unit-
prism portion arranged on the first incident plane, a ray of light
expected to be incident on the ineffective plane of another adjacent
refraction type prism portion placed on a Fresnel periphery side is
received in the subsidiary unit-prism portion, and

the subsidiary unit-prism portion functions as a total reflection type prism portion having both a second incident plane, on which a ray of light is received, and a total reflection plane on which the ray of light received on the second incident plane is totally reflected to
5 be deflected in the desired direction.

31. A Fresnel lens according to claim 30, wherein a plane obtained by extending the second incident plane of each subsidiary unit-prism portion is placed in a position shifted from the ineffective plane
10 toward a light outgoing side in a range of the corresponding refraction type prism portion.

32. A Fresnel lens according to claim 30, wherein a ratio of each subsidiary unit-prism portion to the corresponding first incident
15 plane differs from those of the other subsidiary unit-prism portions.

33. A Fresnel lens according to claim 31, wherein a ratio of each subsidiary unit-prism portion to the corresponding first incident plane differs from those of the other subsidiary unit-prism portions.
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34. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 26; and

a second region indicating the same shape as that of the Fresnel
25 lens according to claim 30.

35. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 26; and

30 a second region indicating the same shape as that of the Fresnel

lens according to claim 31.

36. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens
5 according to claim 26; and

a second region indicating the same shape as that of the Fresnel
lens according to claim 32.

37. A Fresnel lens, comprising:

10 a first region indicating the same shape as that of the Fresnel lens
according to claim 26; and

a second region indicating the same shape as that of the Fresnel
lens according to claim 33.

15 38. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens
according to claim 27; and

a second region indicating the same shape as that of the Fresnel
lens according to claim 30.

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39. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens
according to claim 27; and

a second region indicating the same shape as that of the Fresnel
25 lens according to claim 31.

40. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens
according to claim 27; and

30 a second region indicating the same shape as that of the Fresnel

lens according to claim 32.

41. A Fresnel lens, comprising:

5 a first region indicating the same shape as that of the Fresnel lens according to claim 27; and

a second region indicating the same shape as that of the Fresnel lens according to claim 33.

42. A Fresnel lens, comprising:

10 a first region indicating the same shape as that of the Fresnel lens according to claim 28; and

a second region indicating the same shape as that of the Fresnel lens according to claim 30.

15 43. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 28; and

a second region indicating the same shape as that of the Fresnel lens according to claim 31.

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44. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 28; and

25 a second region indicating the same shape as that of the Fresnel lens according to claim 32.

45. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 28; and

30 a second region indicating the same shape as that of the Fresnel

lens according to claim 33.

46. A Fresnel lens, comprising:

5 a first region indicating the same shape as that of the Fresnel lens according to claim 29; and

a second region indicating the same shape as that of the Fresnel lens according to claim 30.

47. A Fresnel lens, comprising:

10 a first region indicating the same shape as that of the Fresnel lens according to claim 29; and

a second region indicating the same shape as that of the Fresnel lens according to claim 31.

15 48. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 29; and

a second region indicating the same shape as that of the Fresnel lens according to claim 32.

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49. A Fresnel lens, comprising:

a first region indicating the same shape as that of the Fresnel lens according to claim 29; and

25 a second region indicating the same shape as that of the Fresnel lens according to claim 33.

50. A Fresnel lens according to claim 34, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second

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region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

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51. A Fresnel lens according to claim 35, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

52. A Fresnel lens according to claim 36, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased

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as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

53. A Fresnel lens according to claim 37, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

54. A Fresnel lens according to claim 38, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first

incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

55. A Fresnel lens according to claim 39, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

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56. A Fresnel lens according to claim 40, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the

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subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

5 57. A Fresnel lens according to claim 41, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the
10 corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the
15 subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

58. A Fresnel lens according to claim 42, wherein a ratio of the
20 subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased
25 as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident
30 plane in the second region is decreased as the subsidiary unit-prism

portion is far away from the boundary.

59. A Fresnel lens according to claim 43, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident
5 plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary,
10 a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism
15 portion is far away from the boundary.

60. A Fresnel lens according to claim 44, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident
20 plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary,
a ratio of the subsidiary unit-prism portion to the corresponding first
25 incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

61. A Fresnel lens according to claim 45, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

62. A Fresnel lens according to claim 46, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

63. A Fresnel lens according to claim 47, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident

plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased
5 as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident
10 plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

64. A Fresnel lens according to claim 48, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident
15 plane in the first region is increased as the subsidiary unit-prism portion approaches a boundary between the first region and the second region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary,
20 a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism
25 portion is far away from the boundary.

65. A Fresnel lens according to claim 49, wherein a ratio of the subsidiary unit-prism portion to the corresponding second incident
plane in the first region is increased as the subsidiary unit-prism
30 portion approaches a boundary between the first region and the second

region, the ratio of the subsidiary unit-prism portion to the corresponding second incident plane in the first region is decreased as the subsidiary unit-prism portion is far away from the boundary, a ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is increased as the subsidiary unit-prism portion approaches the boundary, and the ratio of the subsidiary unit-prism portion to the corresponding first incident plane in the second region is decreased as the subsidiary unit-prism portion is far away from the boundary.

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66. A Fresnel lens according to claim 26, wherein a second Fresnel lens different from the Fresnel lens arranged on a plane of the light incident side is arranged on a plane of a light outgoing side of the Fresnel lens.

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67. A Fresnel lens according to claim 30, wherein a second Fresnel lens different from the Fresnel lens arranged on a plane of a light incident side is arranged on a plane of a light outgoing side of the Fresnel lens.

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68. A screen, comprising:

the Fresnel lens according to one of claims 26 to 65; and
light diffusing means, arranged on a plane of a light outgoing side of the Fresnel lens, for diffusing the rays of light going out from the Fresnel lens.

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69. A screen, comprising:

the Fresnel lens according to claim 66 or 67; and
light diffusing means, arranged on a light outgoing side of the Fresnel lens, for diffusing the rays of light going out from the Fresnel

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lens.

70. An image displaying device, comprising:

the screen according to claim 68;

5 an image light source for emitting a plurality of rays of image light;

and

projection optics means for projecting the rays of image light
emitted from the image light source onto the screen.

10 71. An image displaying device, comprising:

the screen according to claim 69;

an image light source for emitting a plurality of rays of image light;

and

projection optics means for projecting the rays of image light
15 emitted from the image light source onto the screen.

72. A method of manufacturing a lens forming mold, in which a lens
forming mold is cut in a reversed shape of both a refractive type prism
portion and a total reflection type prism portion formed for each pitch

20 area of a Fresnel lens by using a cutting tool, comprising:

a main unit-prism portion cutting step of cutting the lens forming
mold in a reversed shape of the refractive type prism portion of a
cutting pitch area by using the cutting tool; and

a subordinate unit-prism portion cutting step of cutting the lens
25 forming mold in a reversed shape of the total reflection type prism
portion of the cutting pitch area by using the cutting tool on condition
that a plane obtained by extending a total reflection plane in the
reversed shape of the total reflection type prism portion intersects
a trough line placed between the cutting pitch area and another cutting
30 area adjacent to the cutting pitch area on a Fresnel center side or

pass through an area shifted from the trough line toward a light outgoing side, wherein the combination of the main unit-prism portion cutting step and the subordinate unit-prism portion cutting step is repeatedly performed by a prescribed number equal to the number of cutting pitch areas.

73. A method of manufacturing a lens forming mold, in which a lens forming mold is cut in a reversed shape of both a refractive type prism portion and a total reflection type prism portion formed for each pitch area of a Fresnel lens by using a cutting tool, comprising:

a main unit-prism portion cutting step of cutting the lens forming mold in a reversed shape of the total reflection type prism portion of a cutting pitch area by using the cutting tool; and

a subordinate unit-prism portion cutting step of cutting the lens forming mold in a reversed shape of the refractive type prism portion of the cutting pitch area by using the cutting tool on condition that a plane obtained by extending a first incident plane in the reversed shape of the refractive type prism portion intersects a trough line placed between the cutting pitch area and another cutting area adjacent to the cutting pitch area on a Fresnel periphery side or pass through an area shifted from the trough line toward a light outgoing side, wherein the combination of the main unit-prism portion cutting step and the subordinate unit-prism portion cutting step is repeatedly performed by a prescribed number equal to the number of cutting pitch areas.

74. A method of manufacturing a lens forming mold according to claim 72, further comprising:

a pitch margin setting step for setting a pitch margin for each cutting pitch area before the subordinate unit-prism portion cutting

step in cases where the lens forming mold is cut in a cut performing direction from the Fresnel center side to a Fresnel periphery side in the order of the total reflection type prism portion and the refractive type prism portion,

- 5 wherein the subordinate unit-prism portion cutting step comprises the steps of:

shifting a cutting start position toward the cut performing direction by the pitch margin; and

- 10 cutting the lens forming mold to form the reversed shape of the refractive type prism portion for each cutting pitch area.

75. A method of manufacturing a lens forming mold according to claim 73, further comprising:

- 15 a pitch margin setting step for setting a pitch margin for each cutting pitch area before the subordinate unit-prism portion cutting step in cases where the lens forming mold is cut in a cut performing direction from a Fresnel periphery side to the Fresnel center side in the order of the refractive type prism portion and the total reflection type prism portion,

- 20 wherein the subordinate unit-prism portion cutting step comprises the steps of:

shifting a cutting start position toward the cut performing direction by the pitch margin; and

- 25 cutting the lens forming mold to form the reversed shape of the total reflection type prism portion for each cutting pitch area.

76. A method of manufacturing a lens forming mold according to claim 73, further comprising the step of:

- 30 successively cutting the lens forming mold in a reversed shape of a plurality of dummy prism portions respectively having a height in

an optical axis direction not related to the reception of light for a group of pitch areas.

77. A method of manufacturing a lens, comprising the steps of:

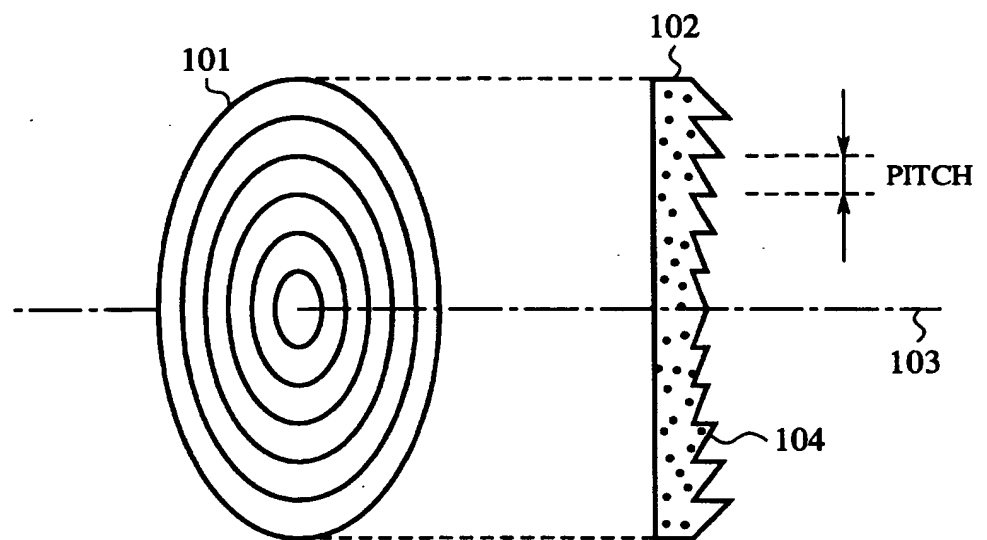
- 5 pouring resin into a lens forming mold manufactured in the method of manufacturing a lens forming mold according to one of claims 72 to 76;

hardening the resin; and

- 10 taking off the lens forming mold from the hardened resin to form a lens.

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FIG.1



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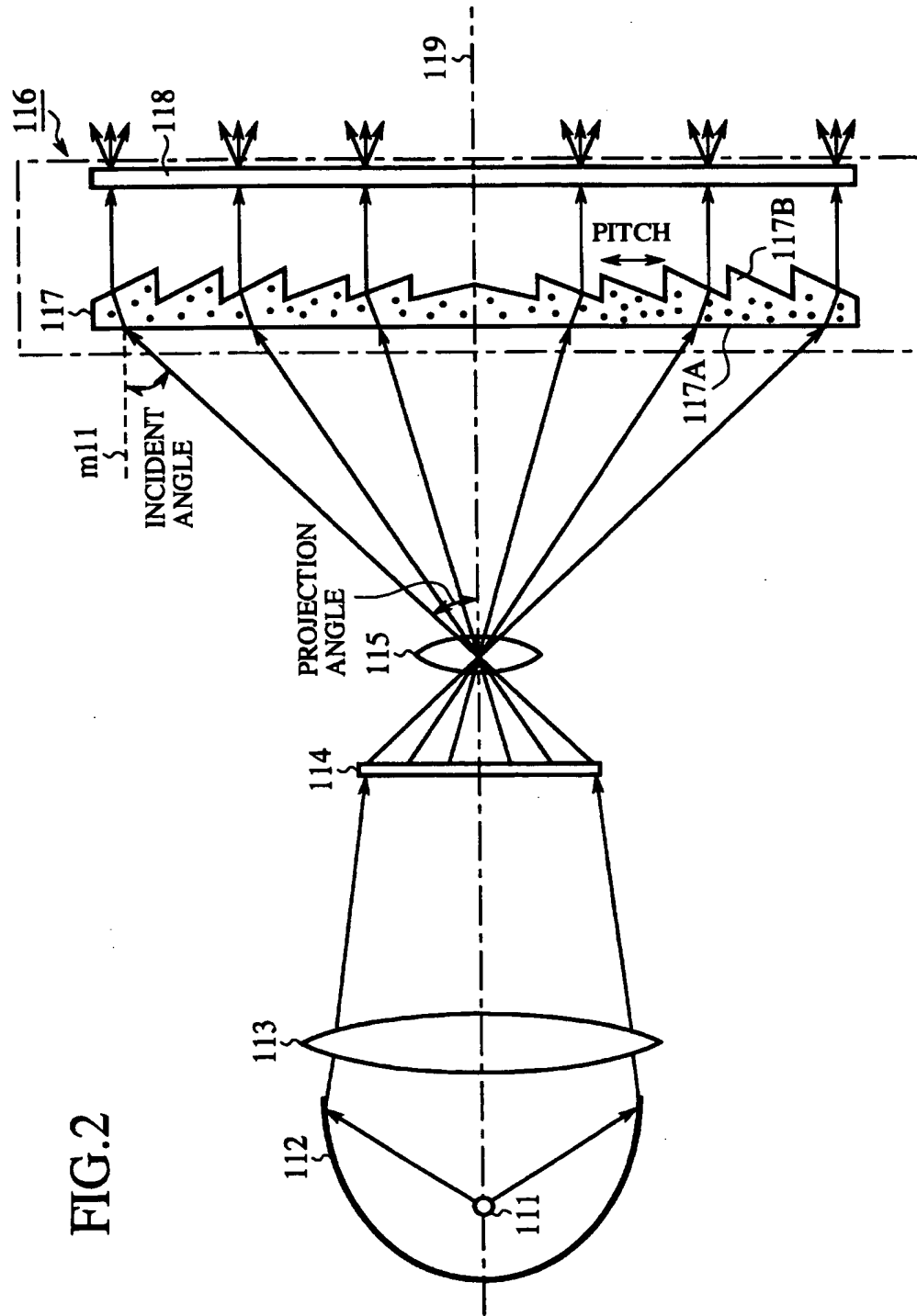


FIG. 2

FIG. 3B

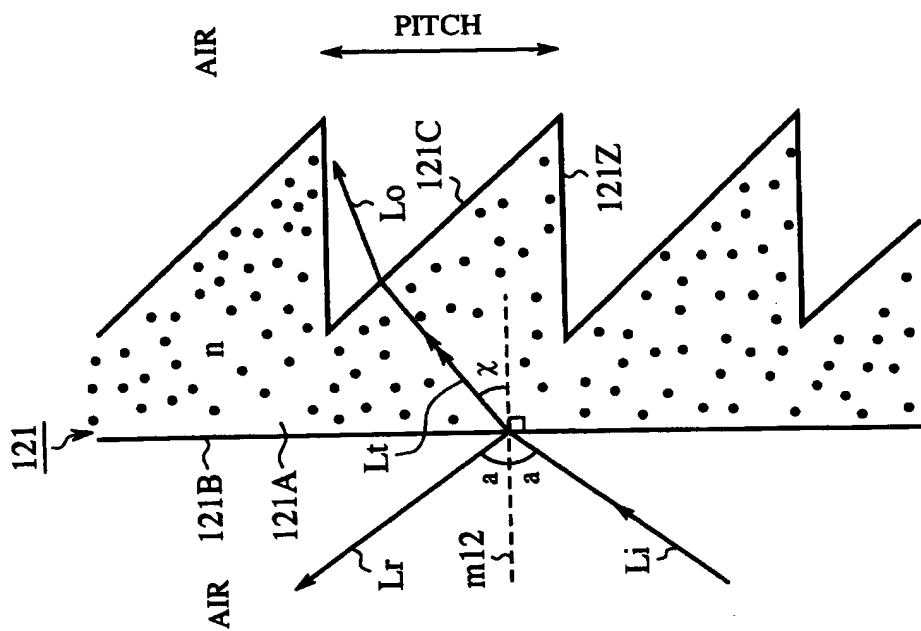


FIG.3A

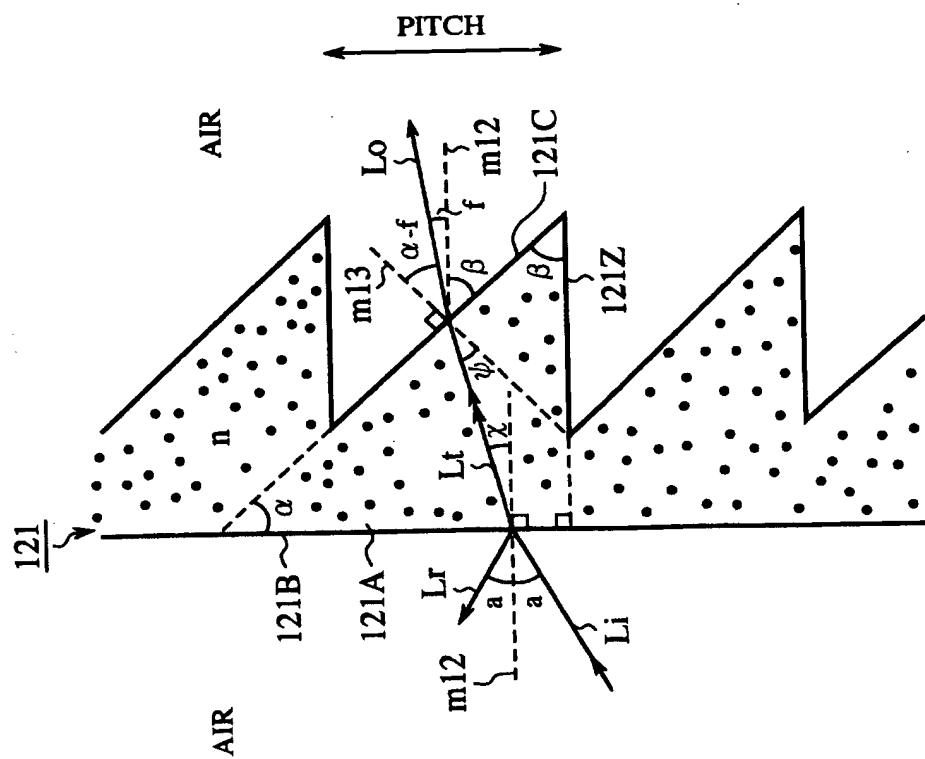


FIG. 4B

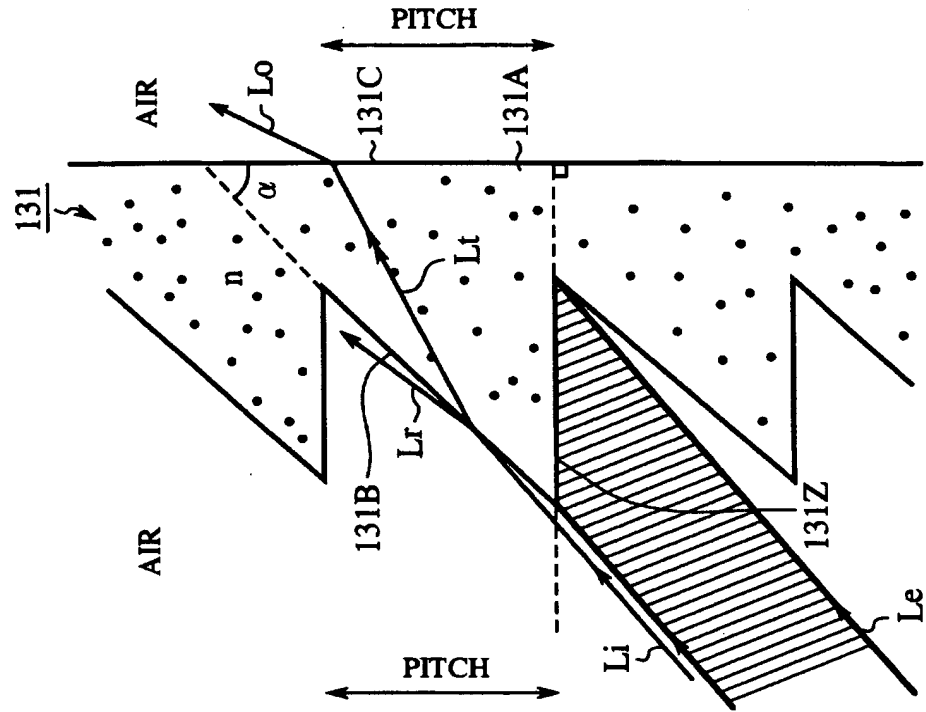


FIG. 4A

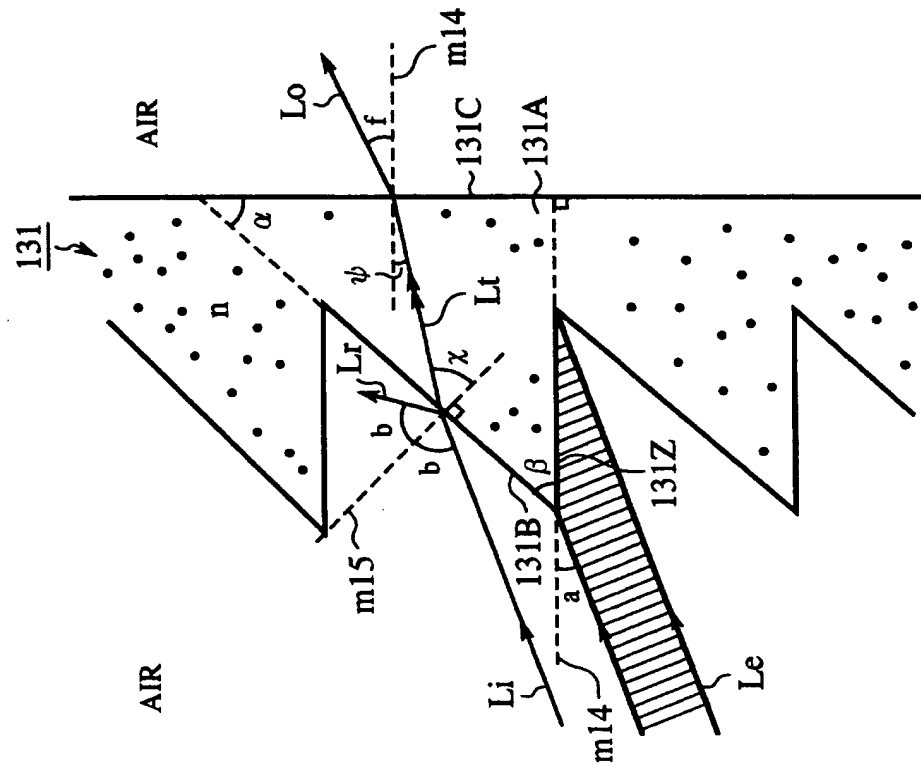


FIG. 5B

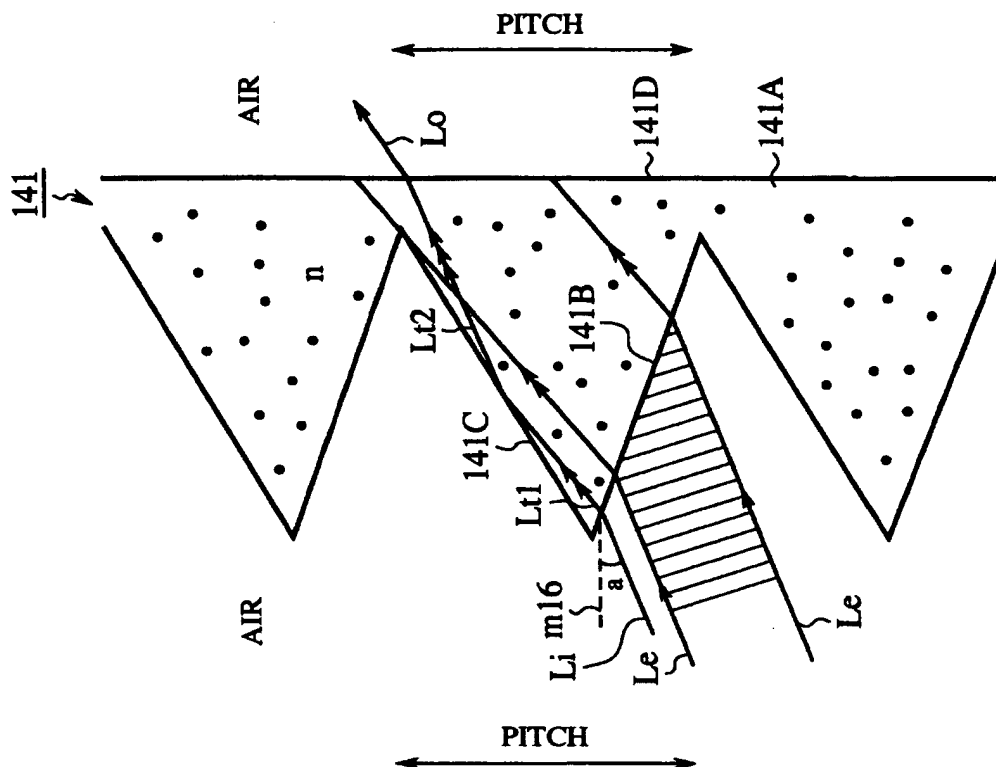
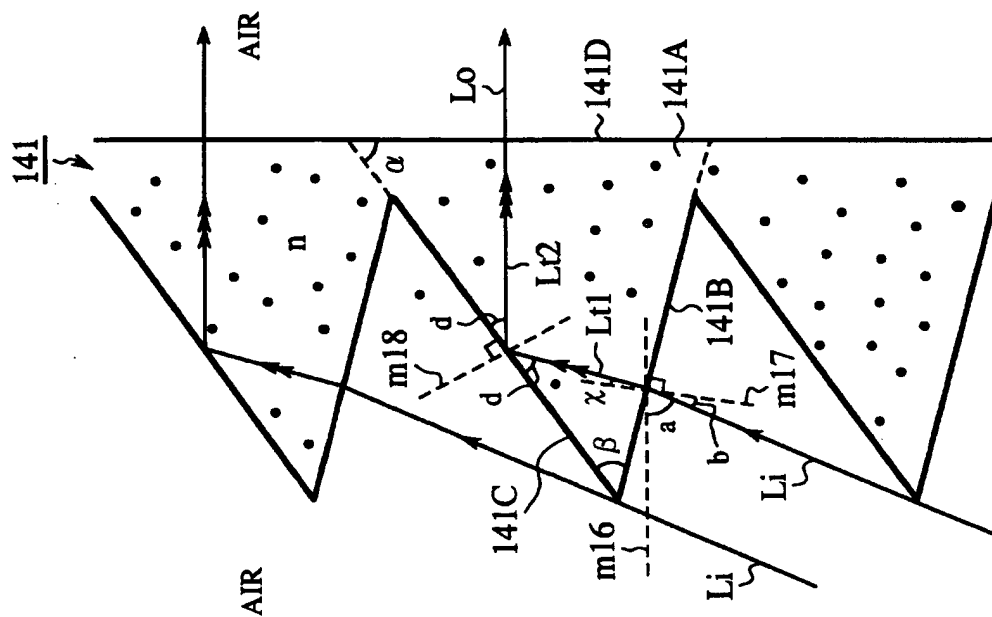
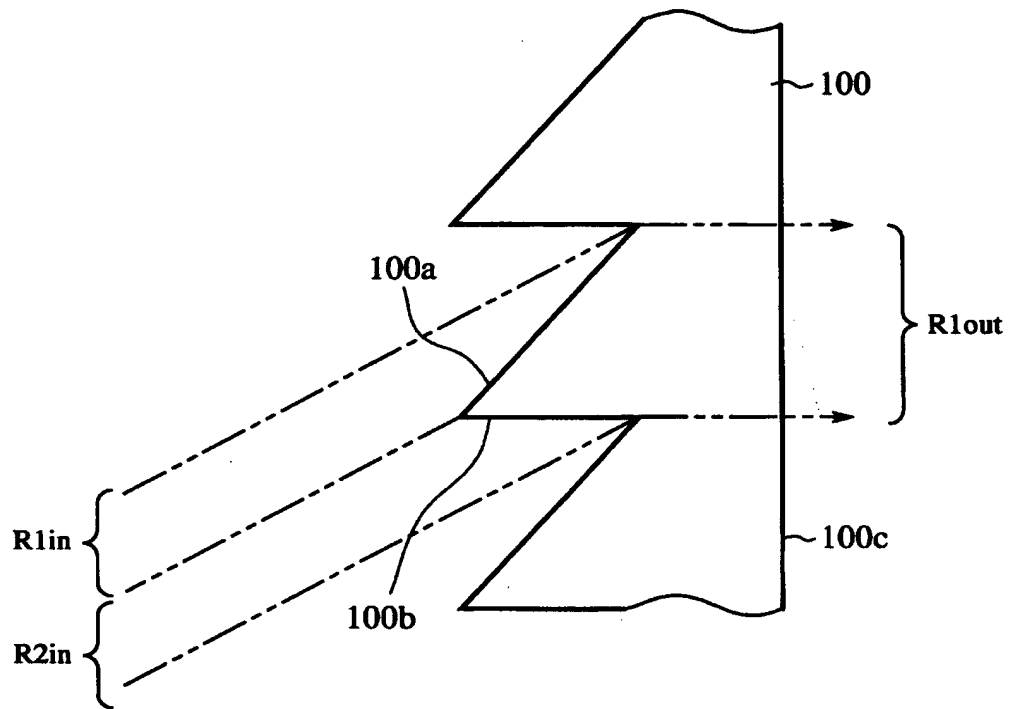


FIG. 5A



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FIG.6



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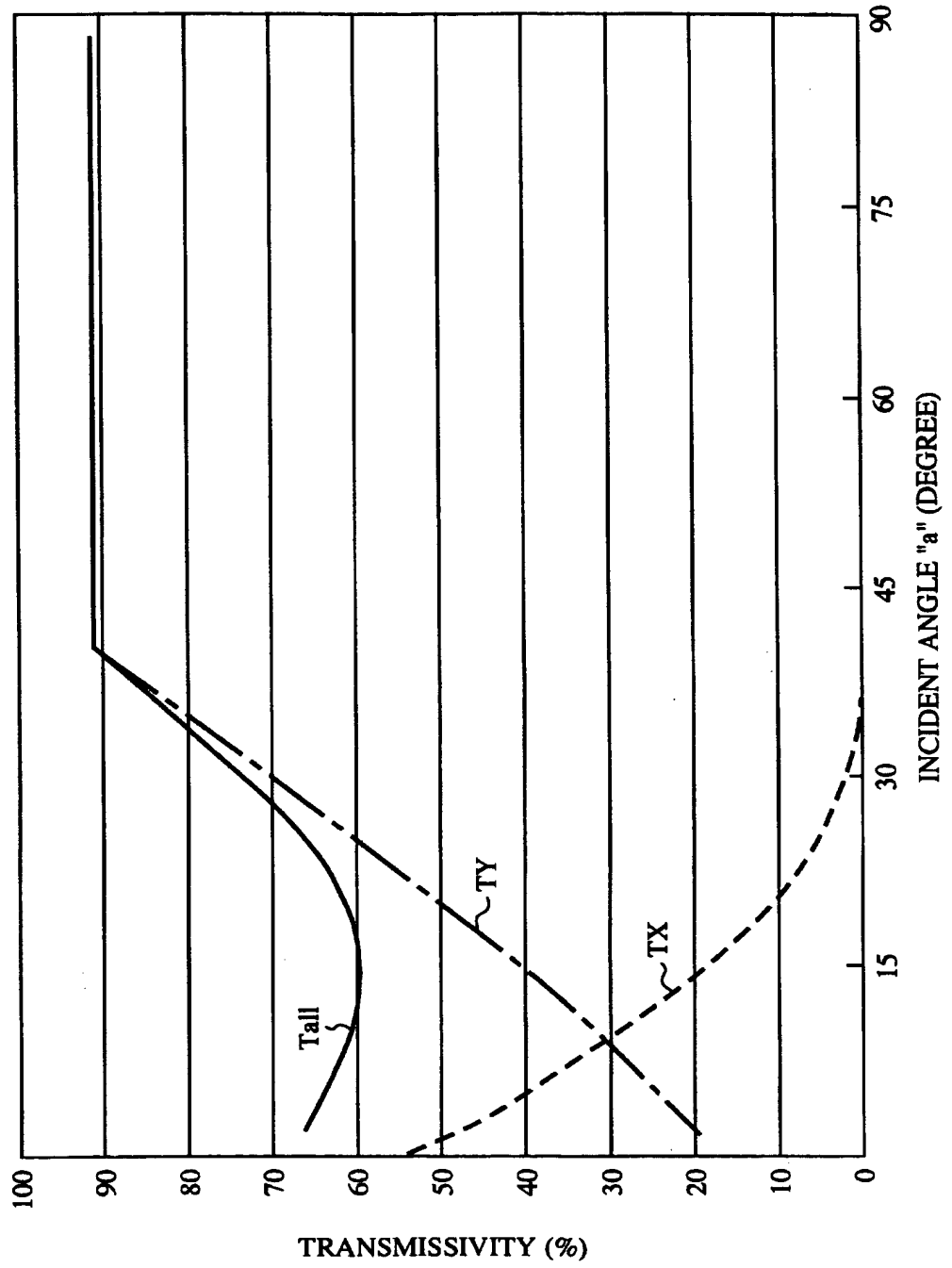


FIG.8

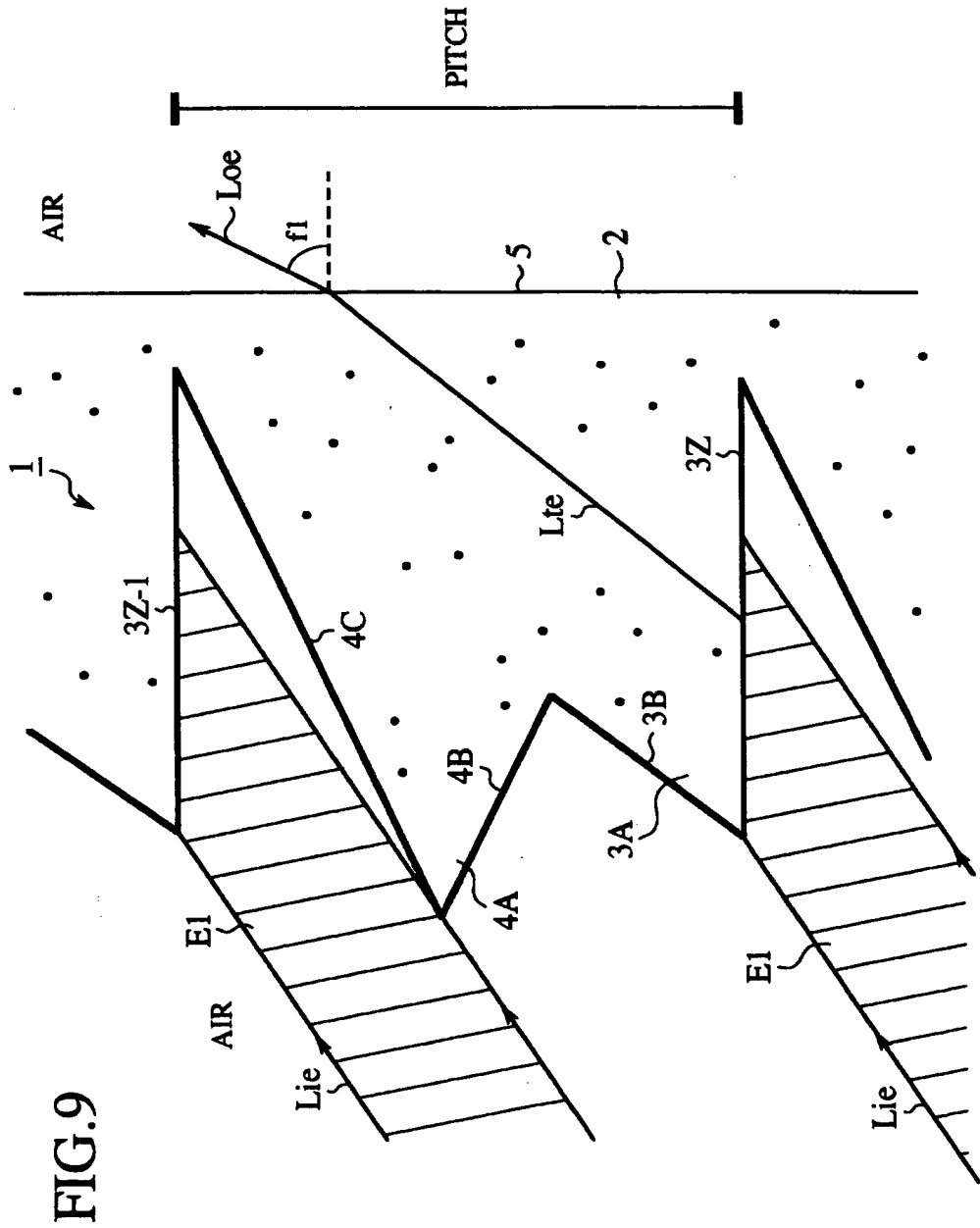
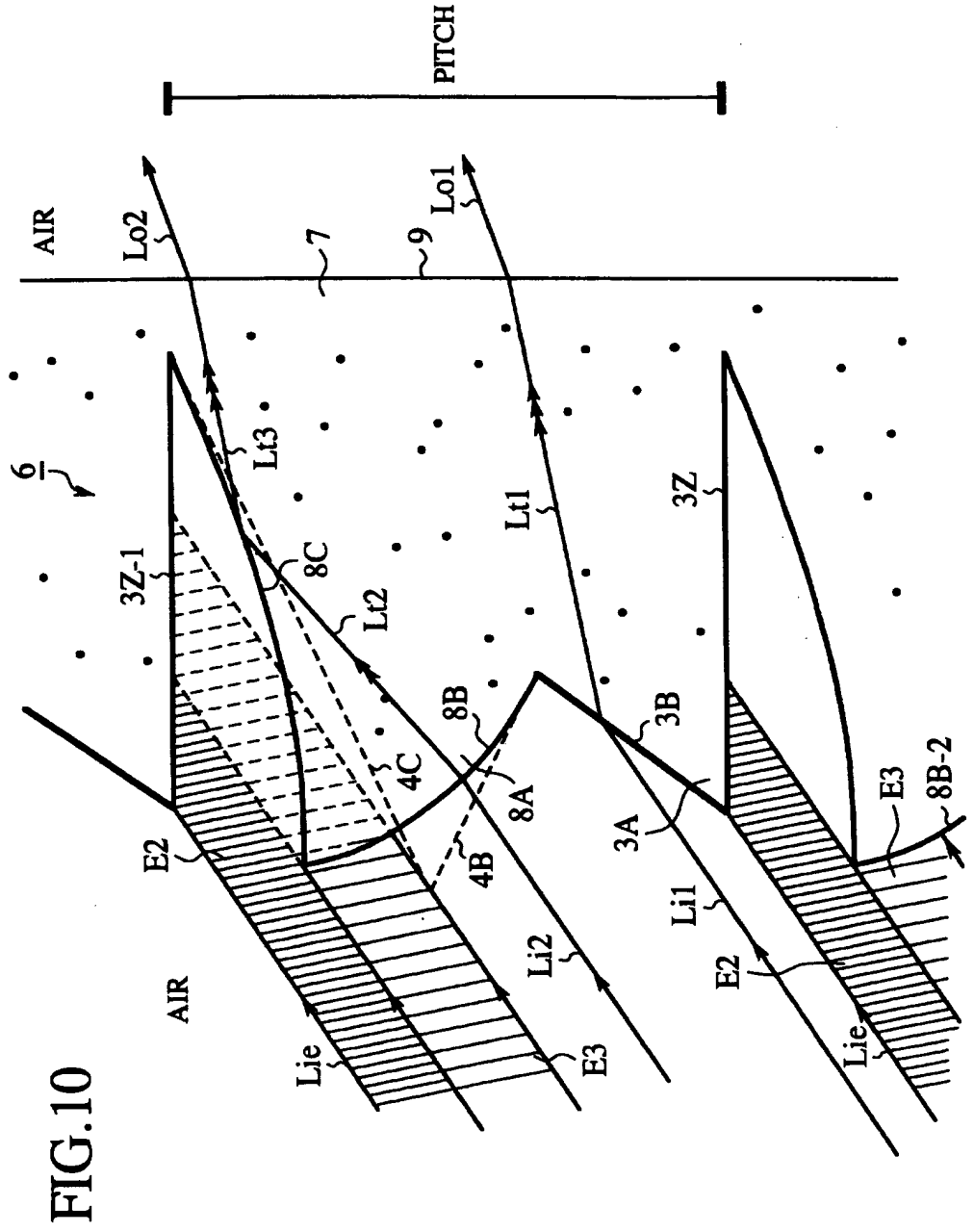


FIG.9

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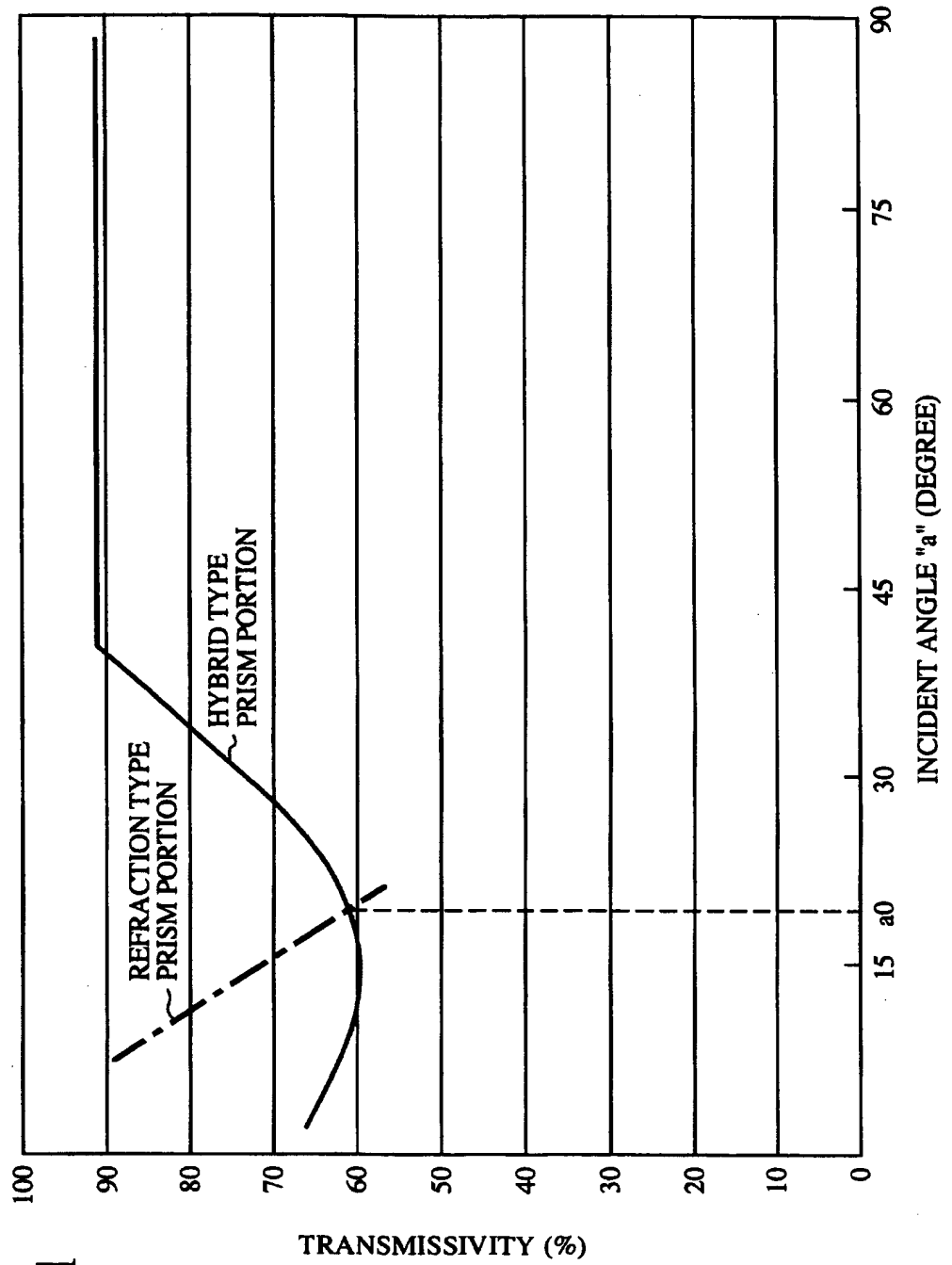
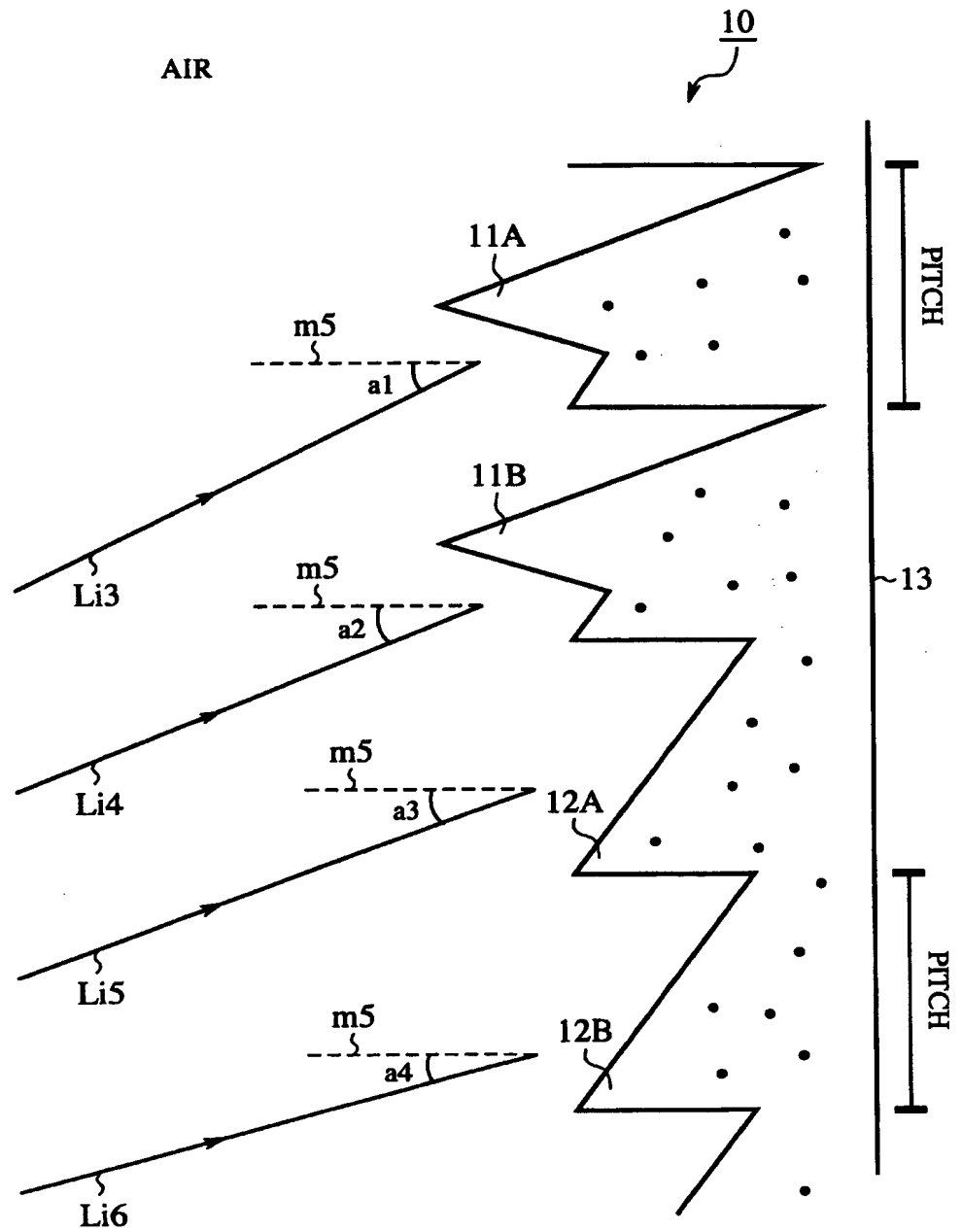


FIG.11

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FIG.12



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FIG.13

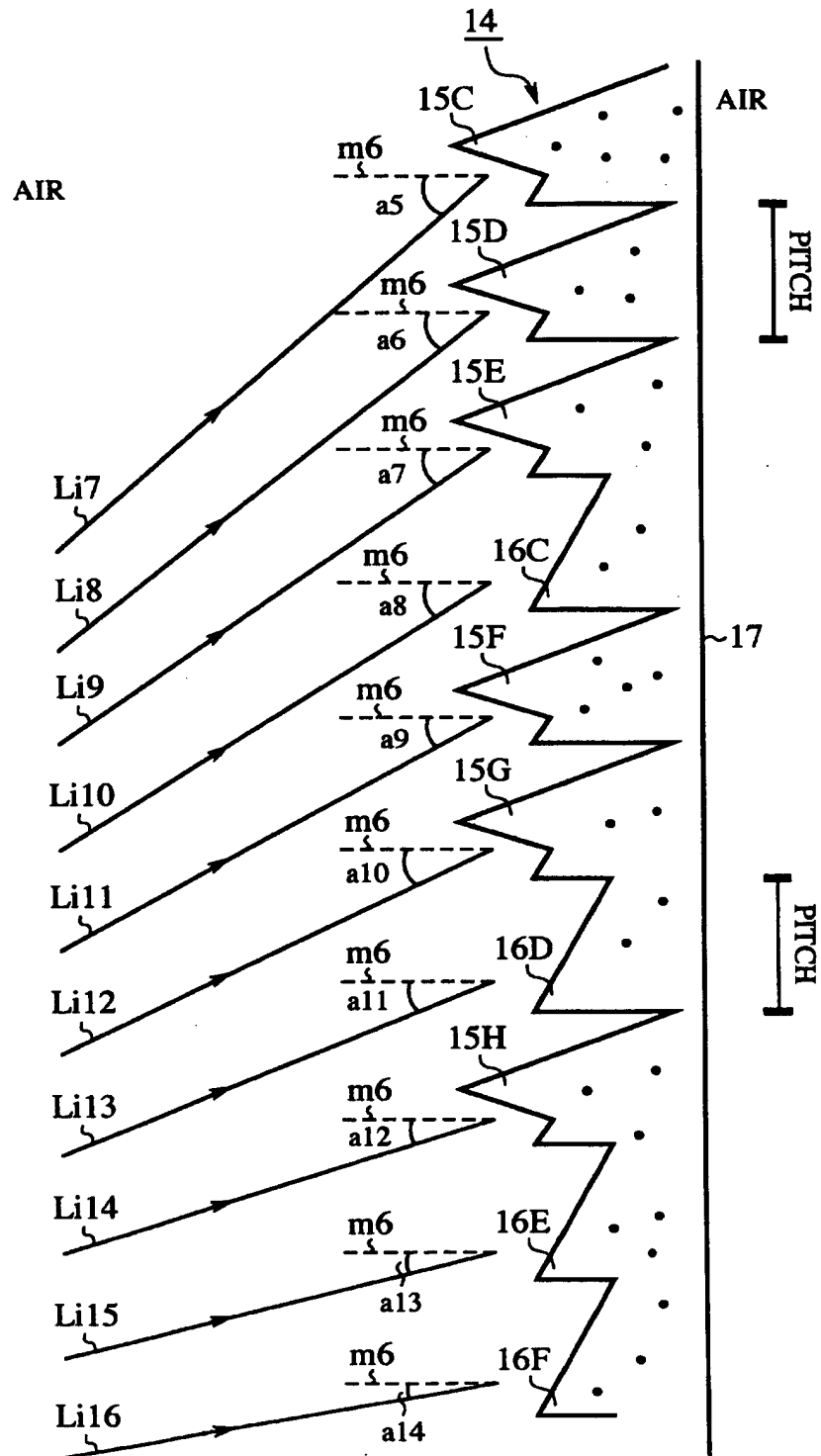
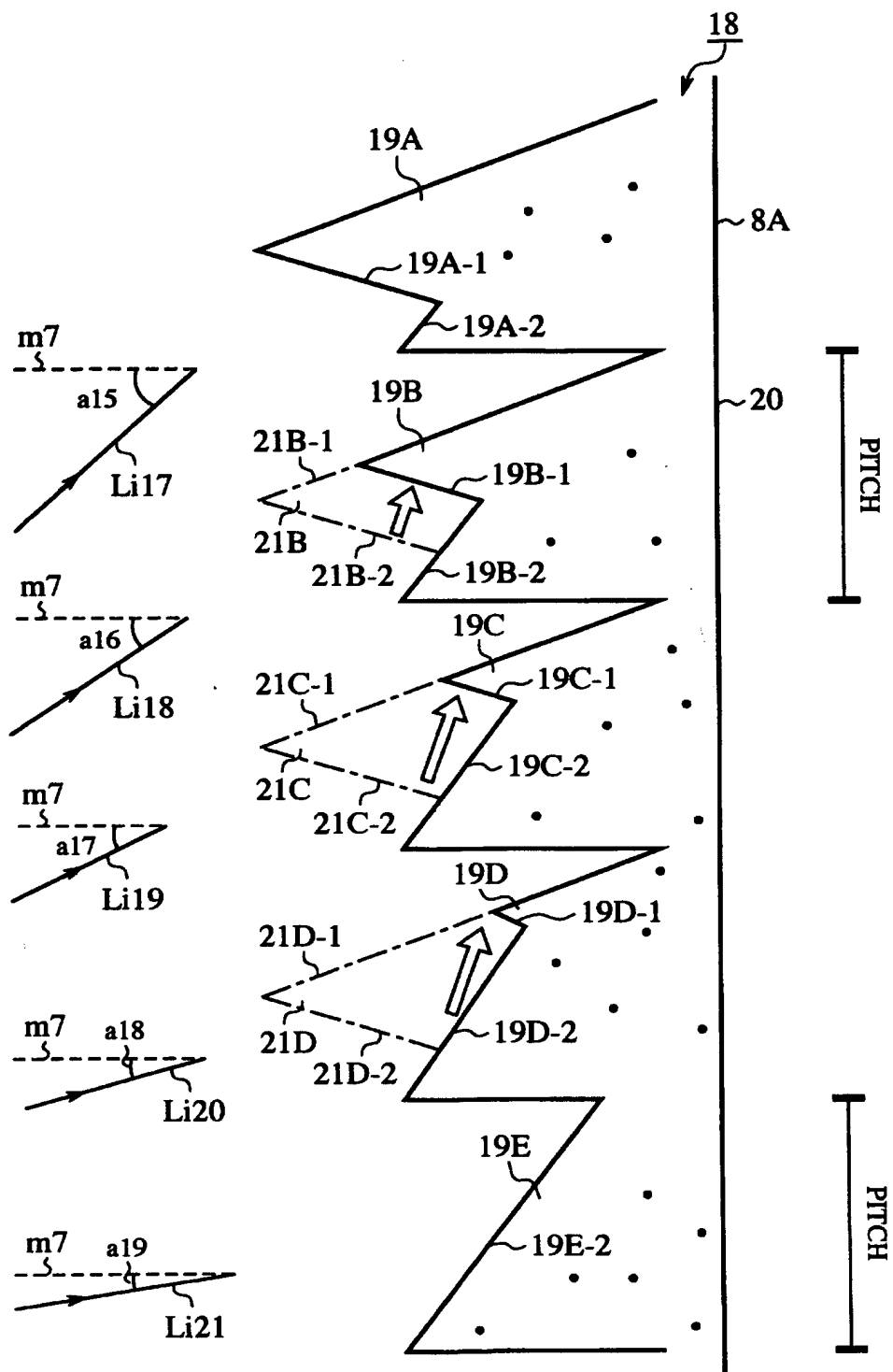
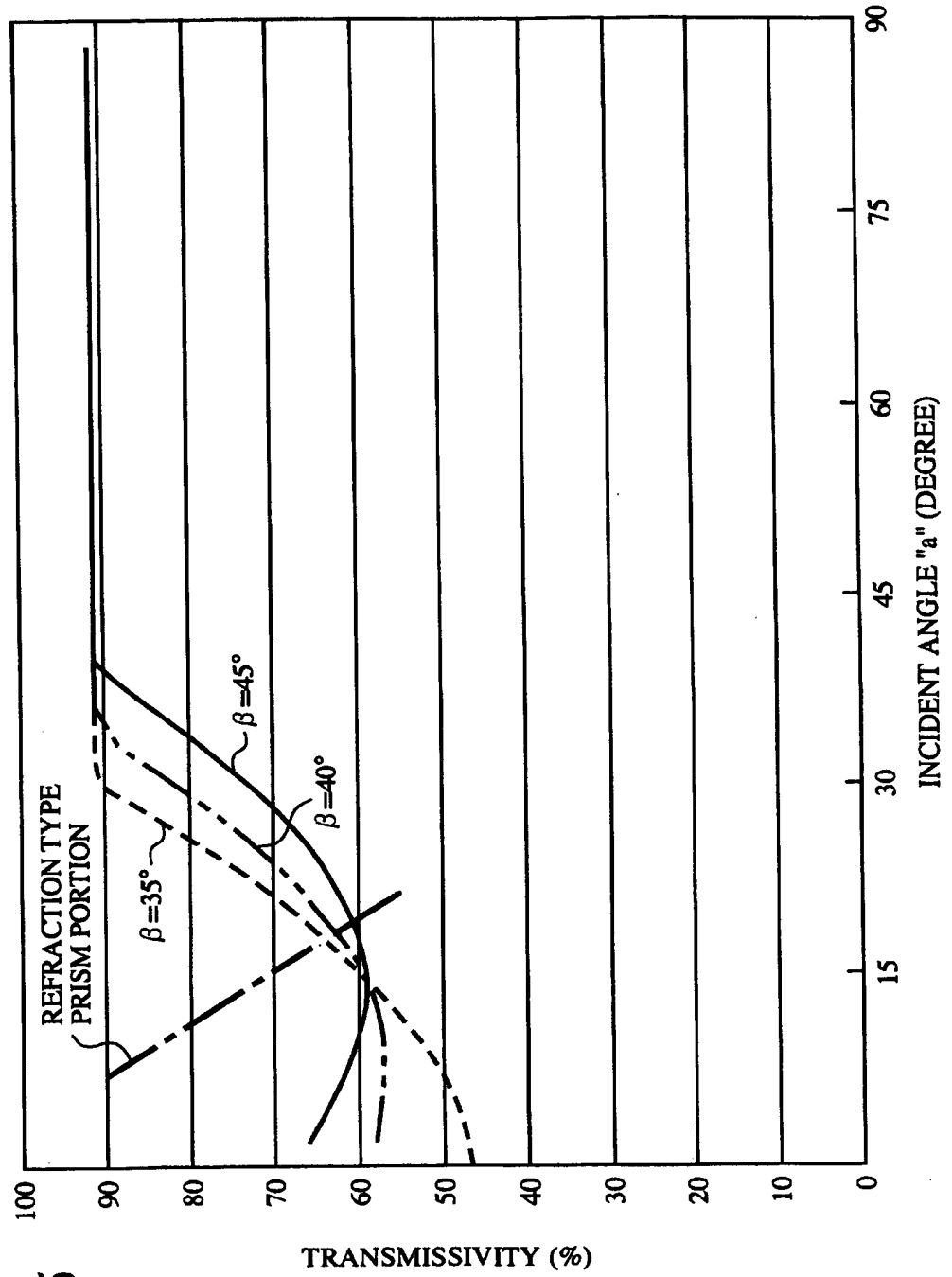


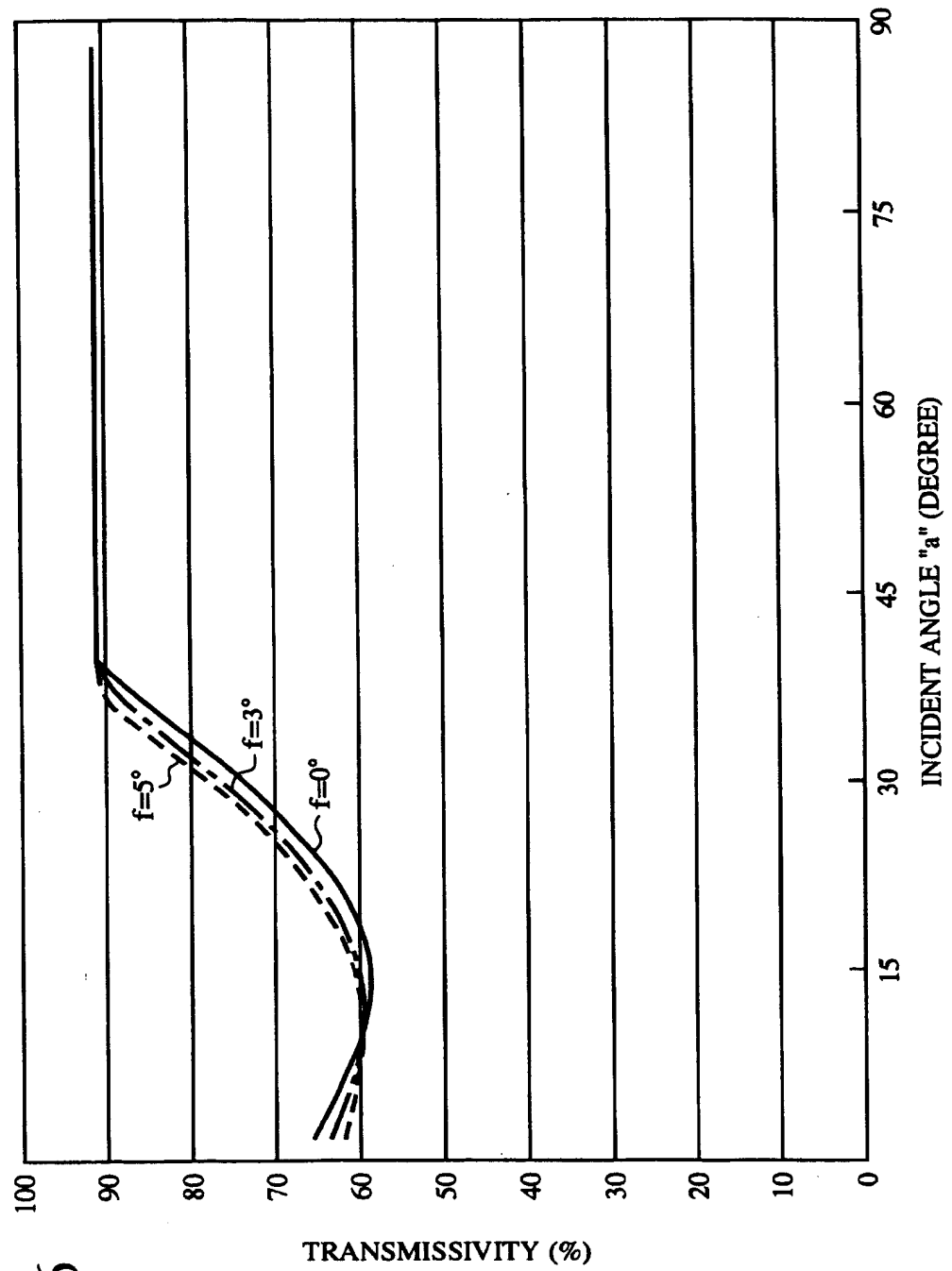
FIG.14



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FIG.17B

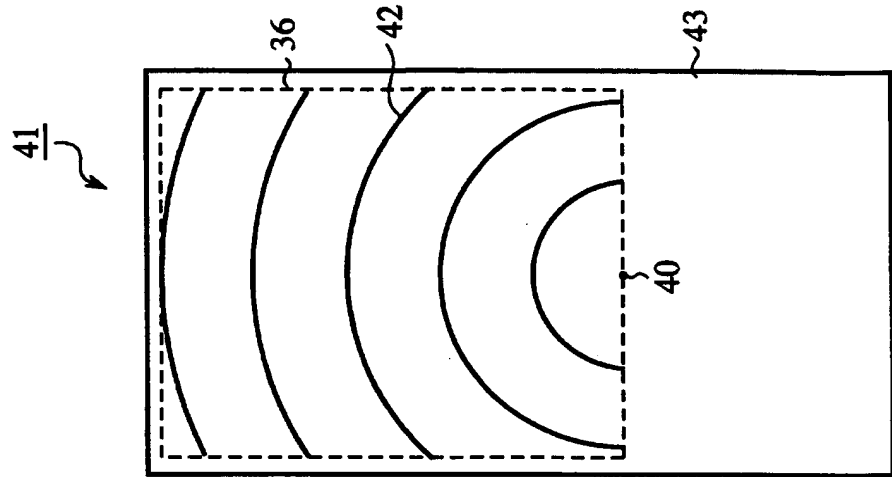
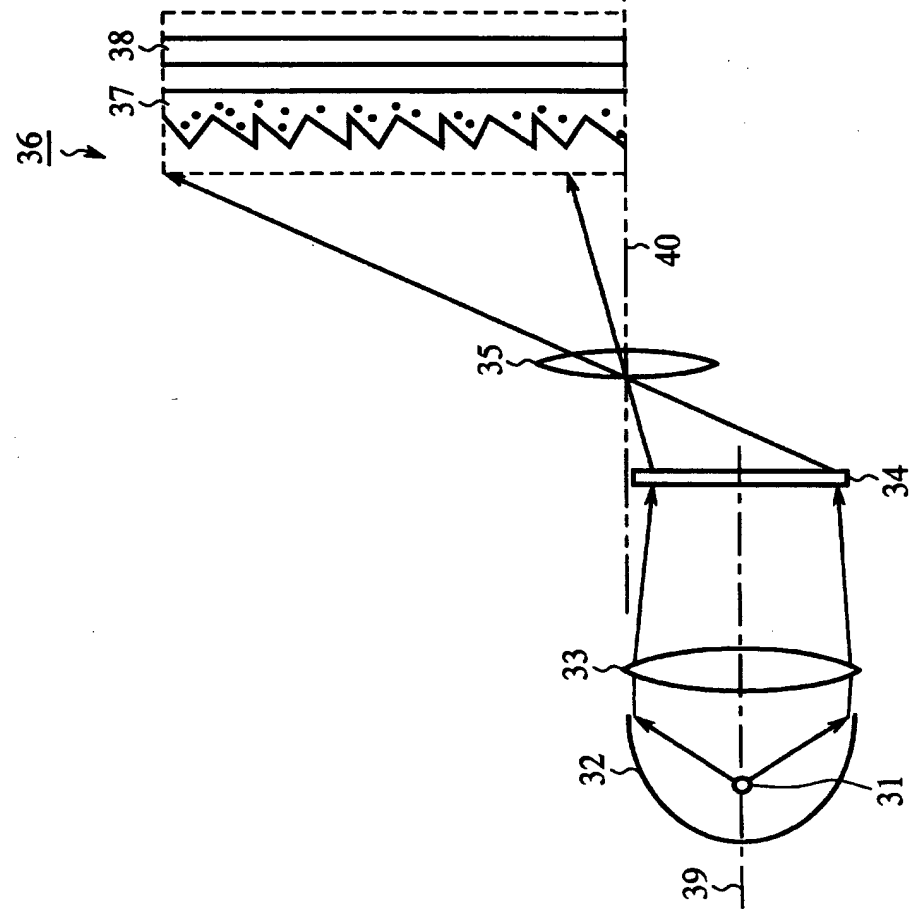


FIG.17A



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FIG.18C

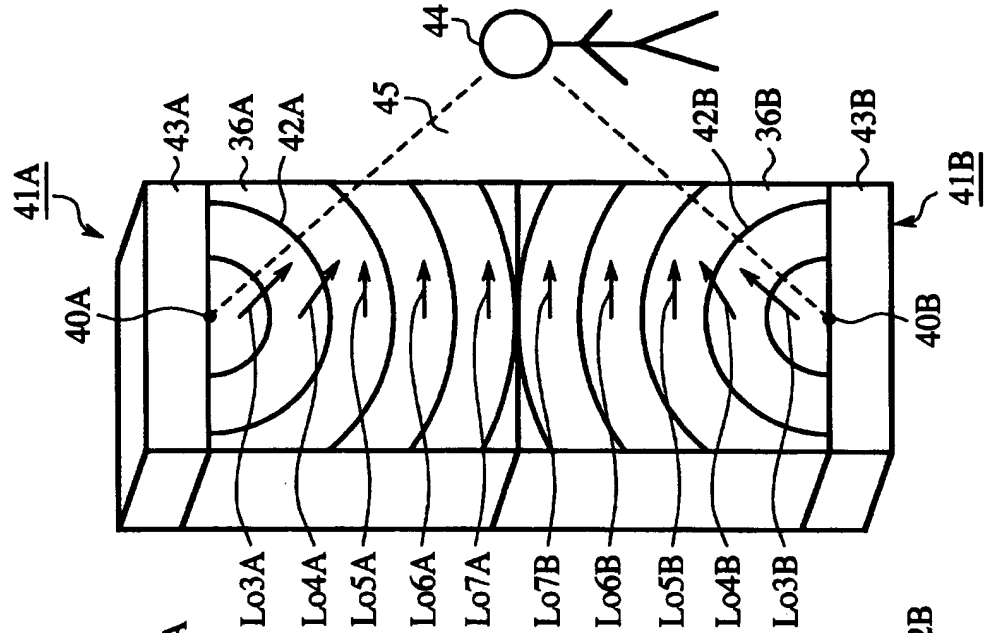


FIG.18B

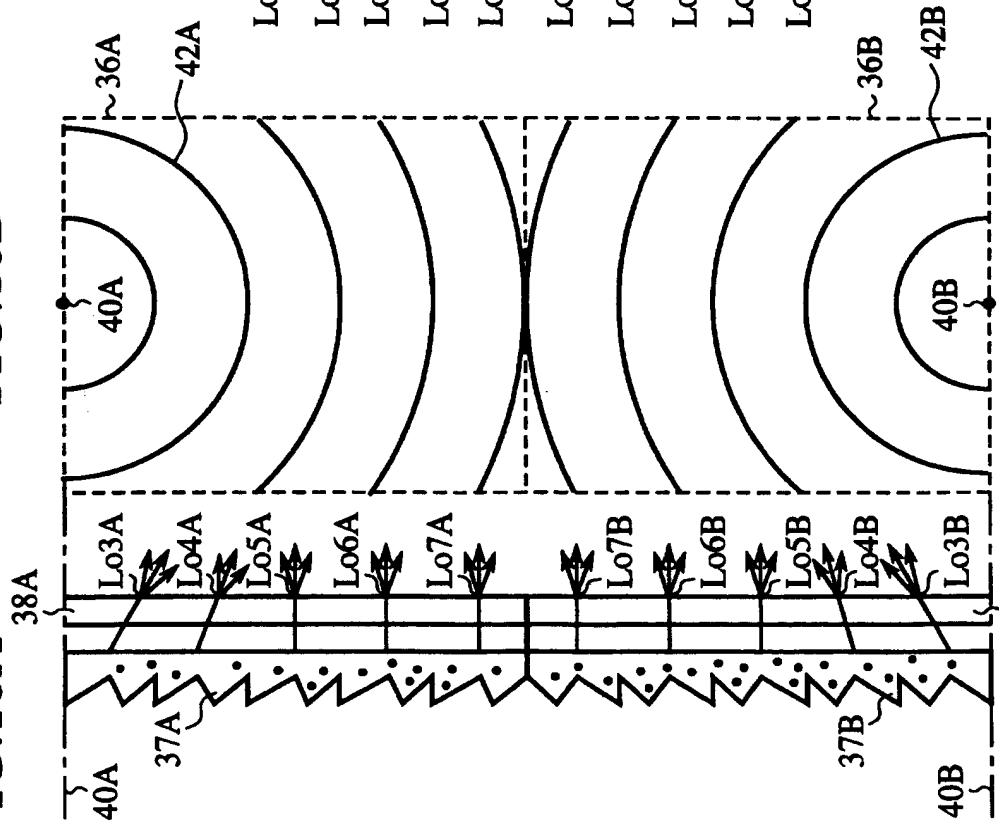
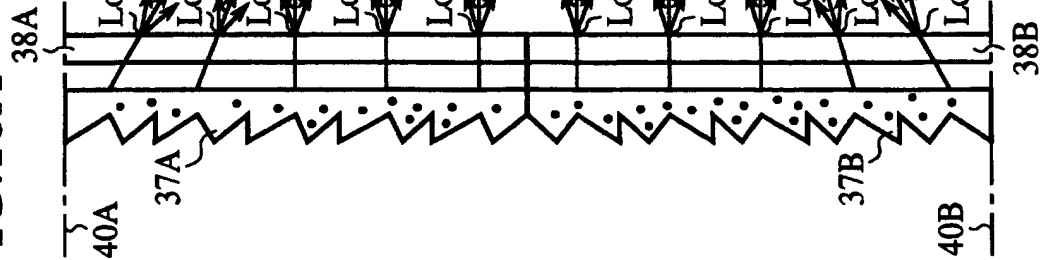


FIG.18A



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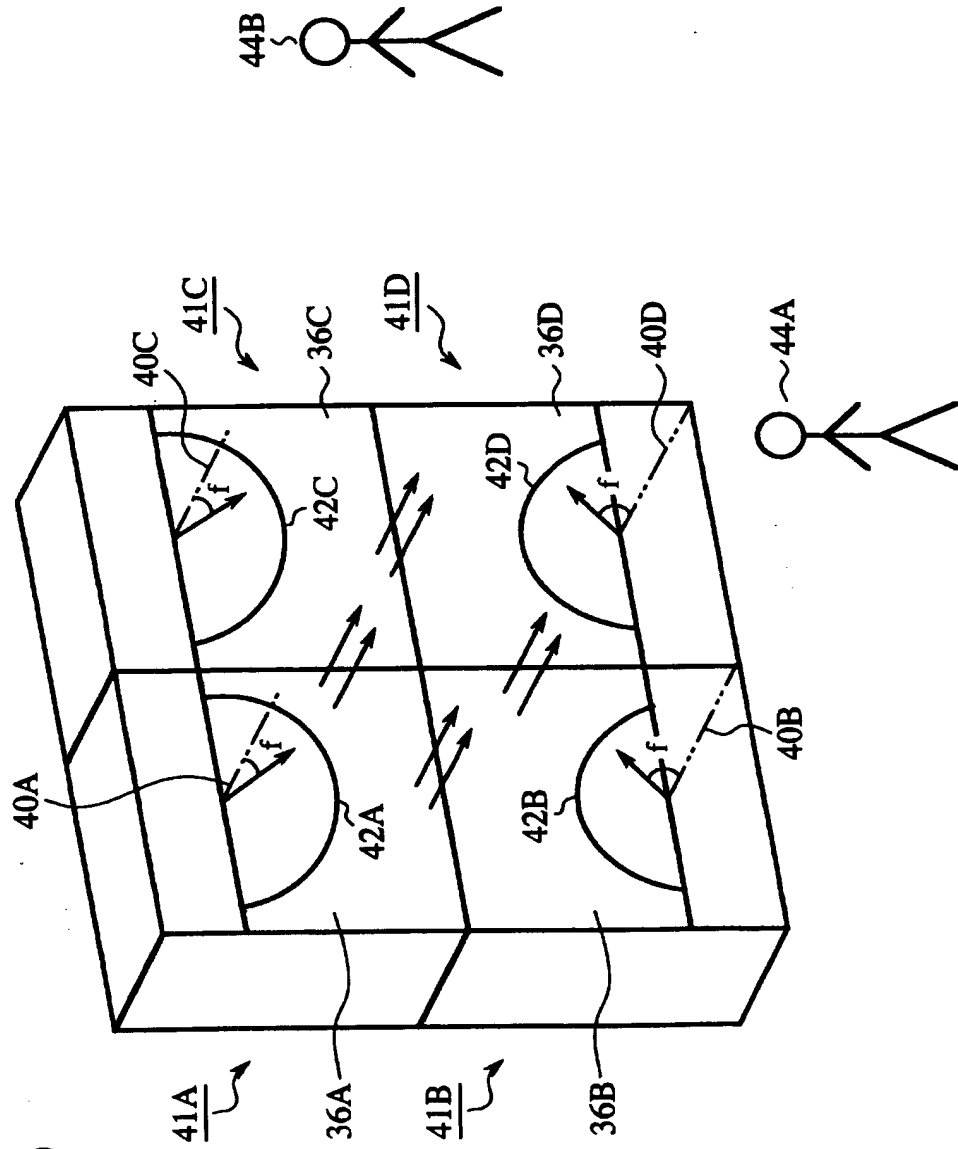


FIG. 19

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FIG.20

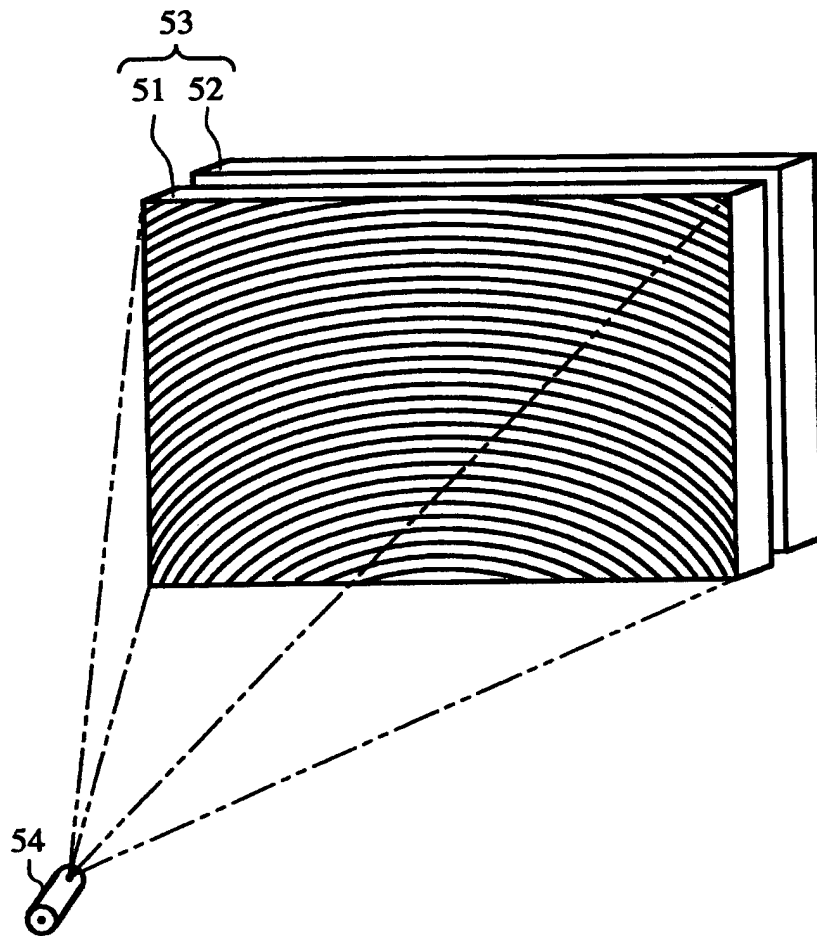
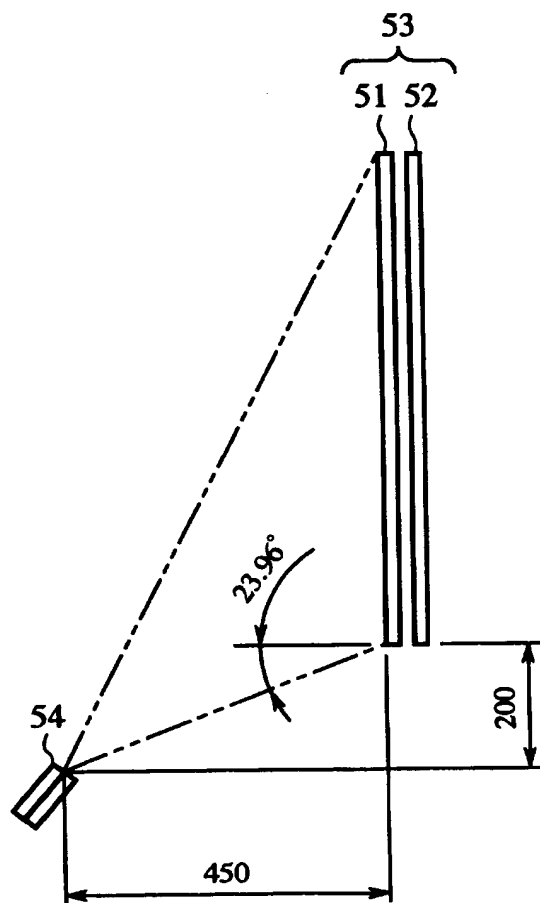
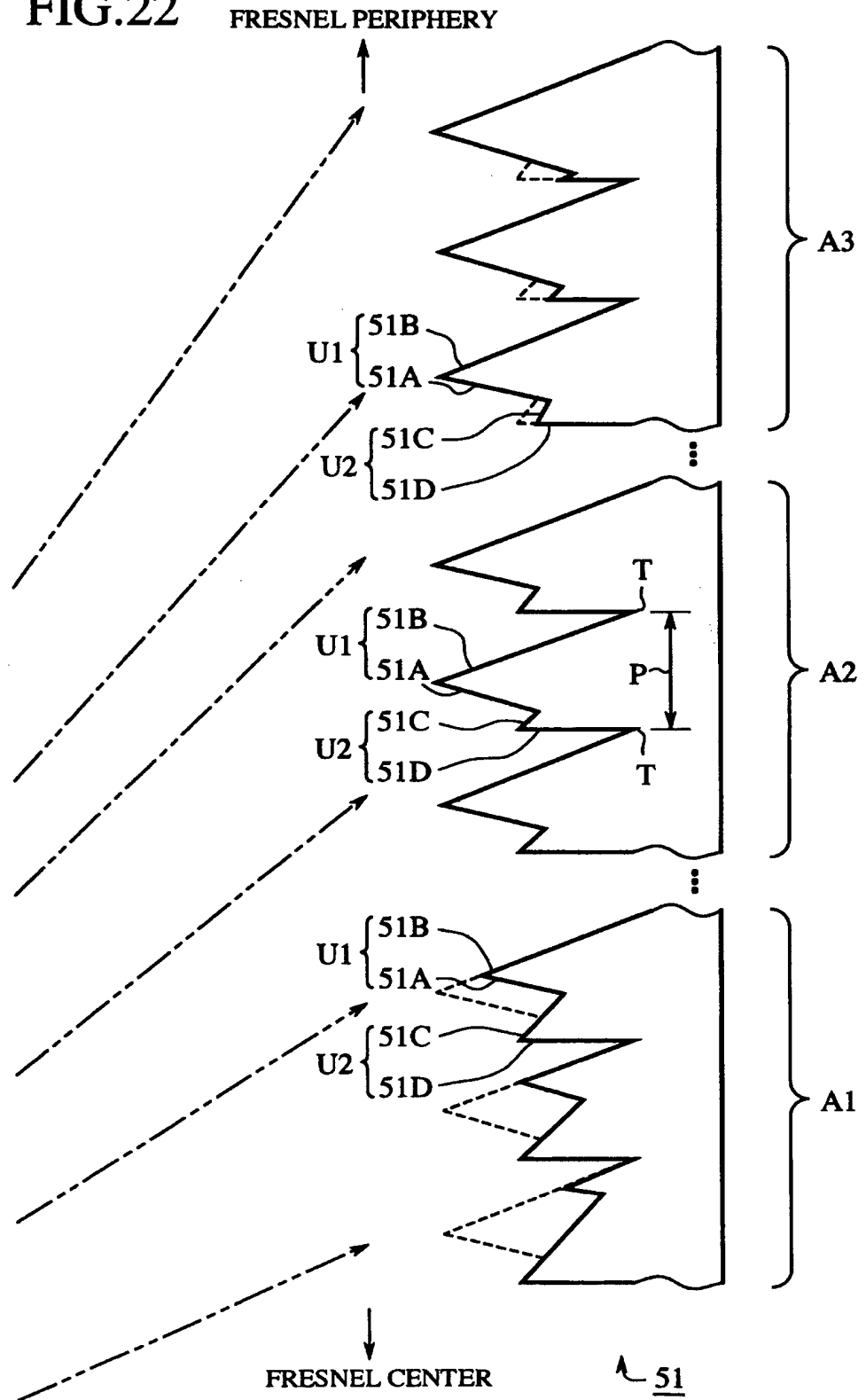


FIG.21



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FIG.22



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FIG.23A

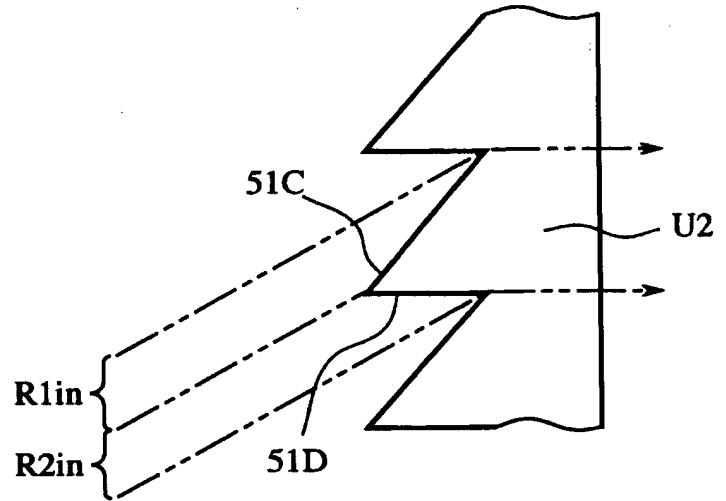


FIG.23B

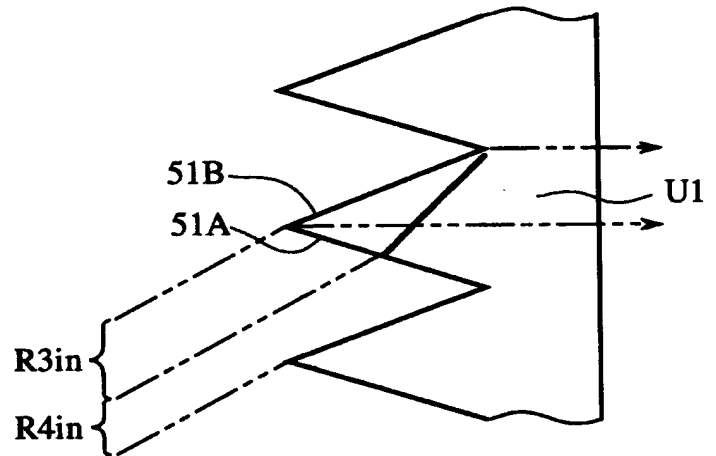
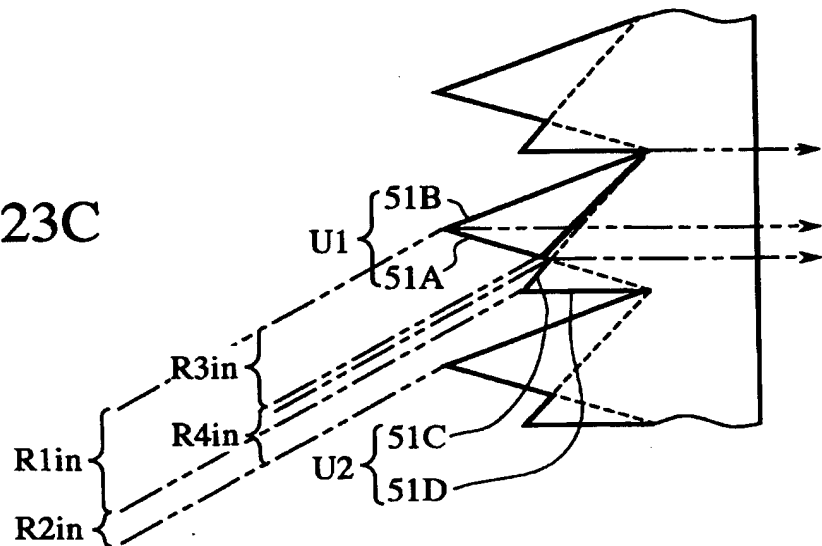


FIG.23C



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FIG.24A

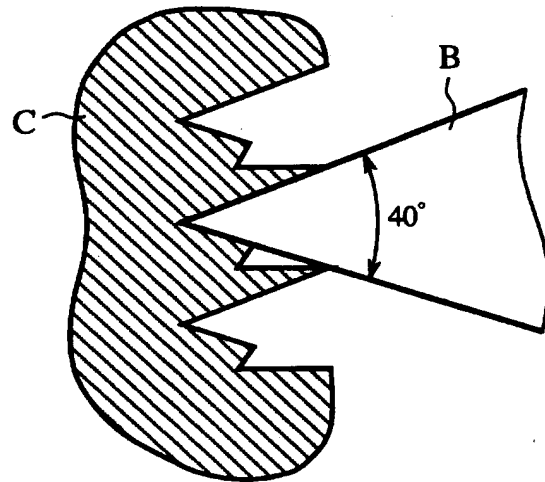


FIG.24B

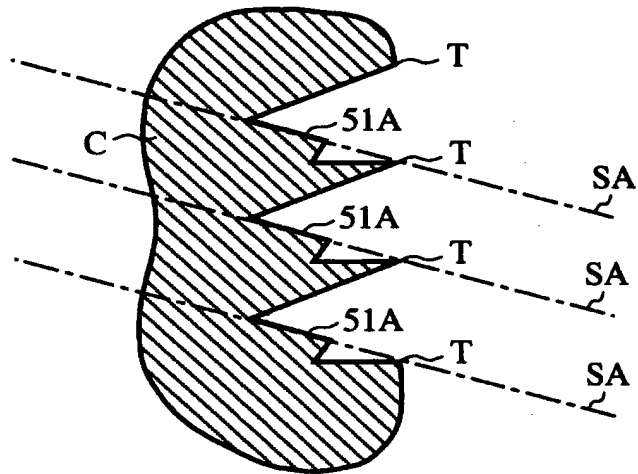
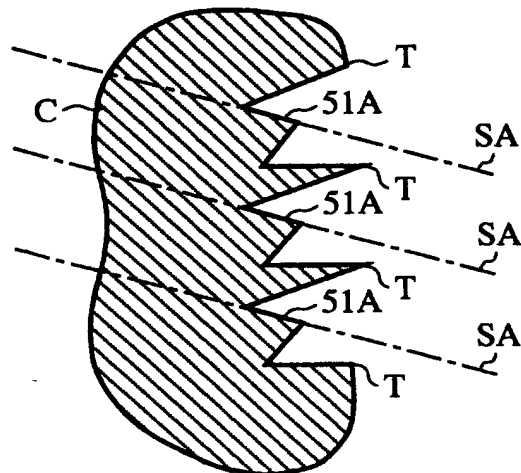


FIG.24C



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FIG.25A

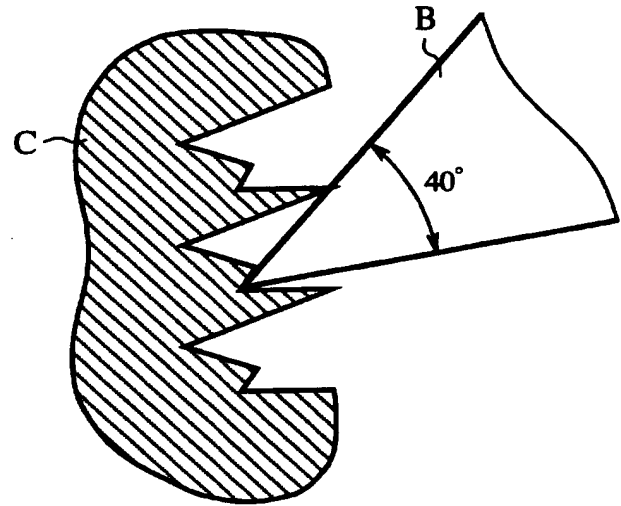


FIG.25B

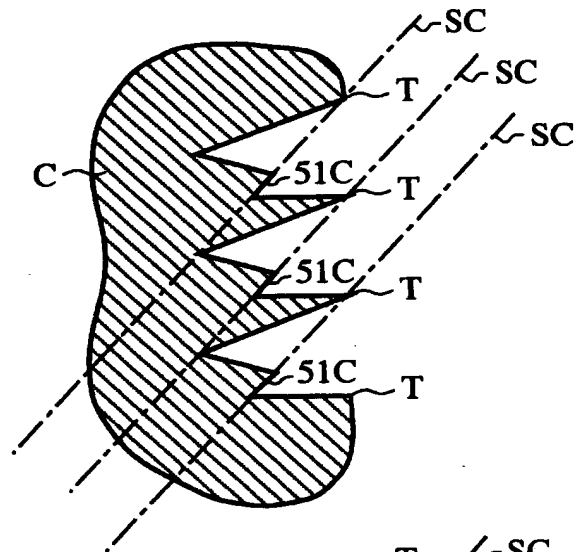
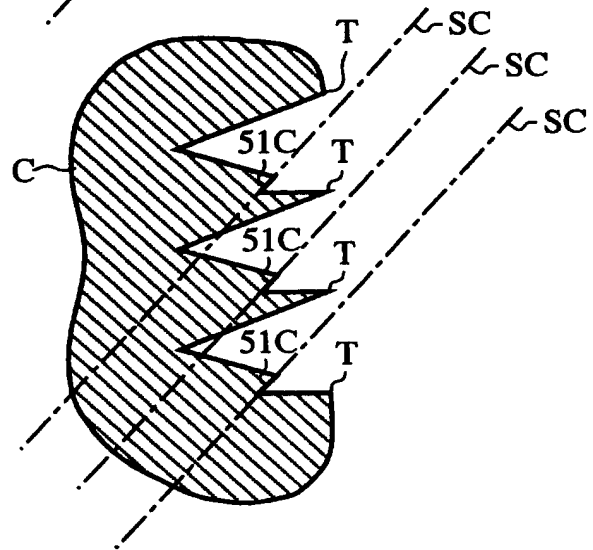
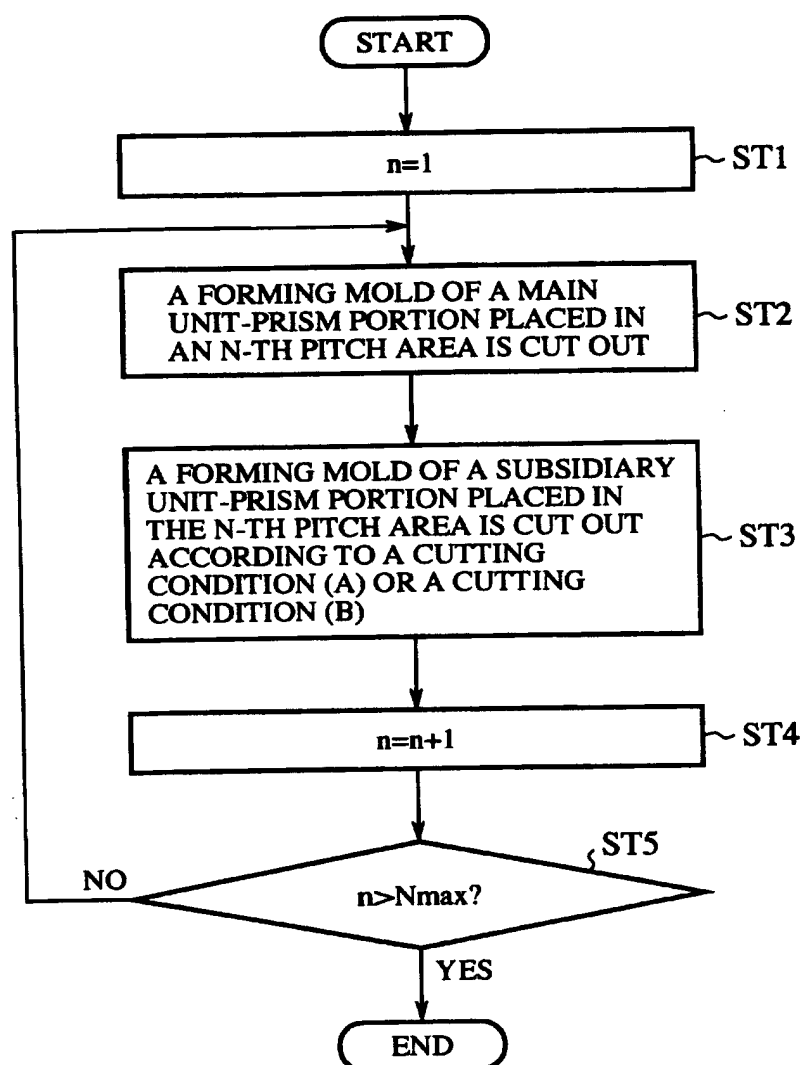


FIG.25C

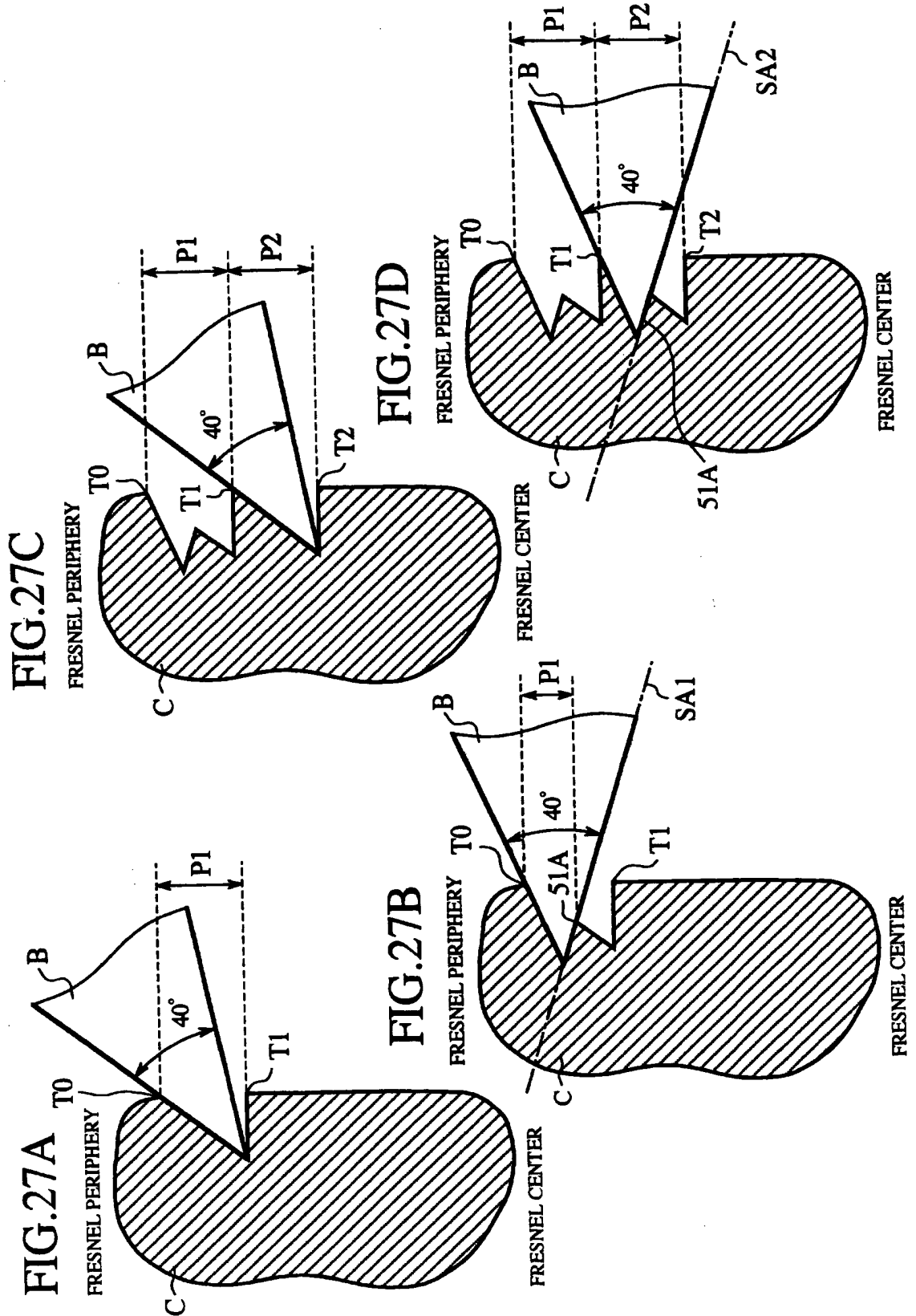


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FIG.26



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FIG.28C

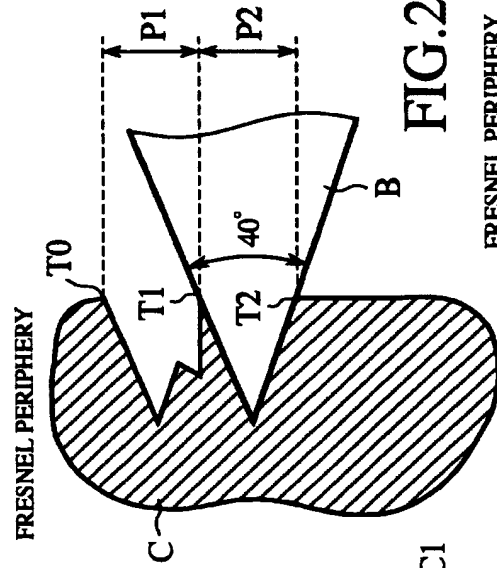


FIG.28D

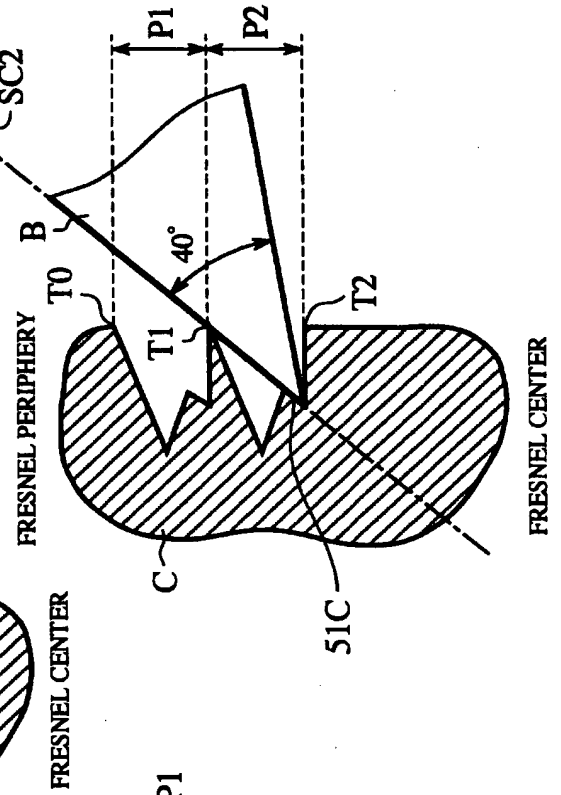


FIG.28A

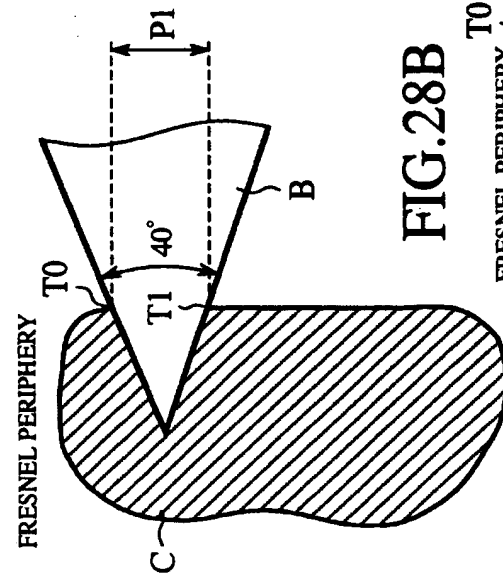
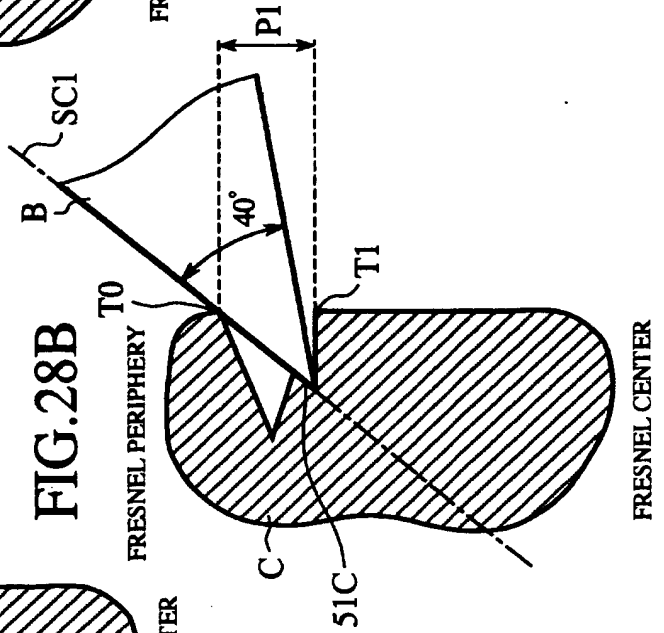
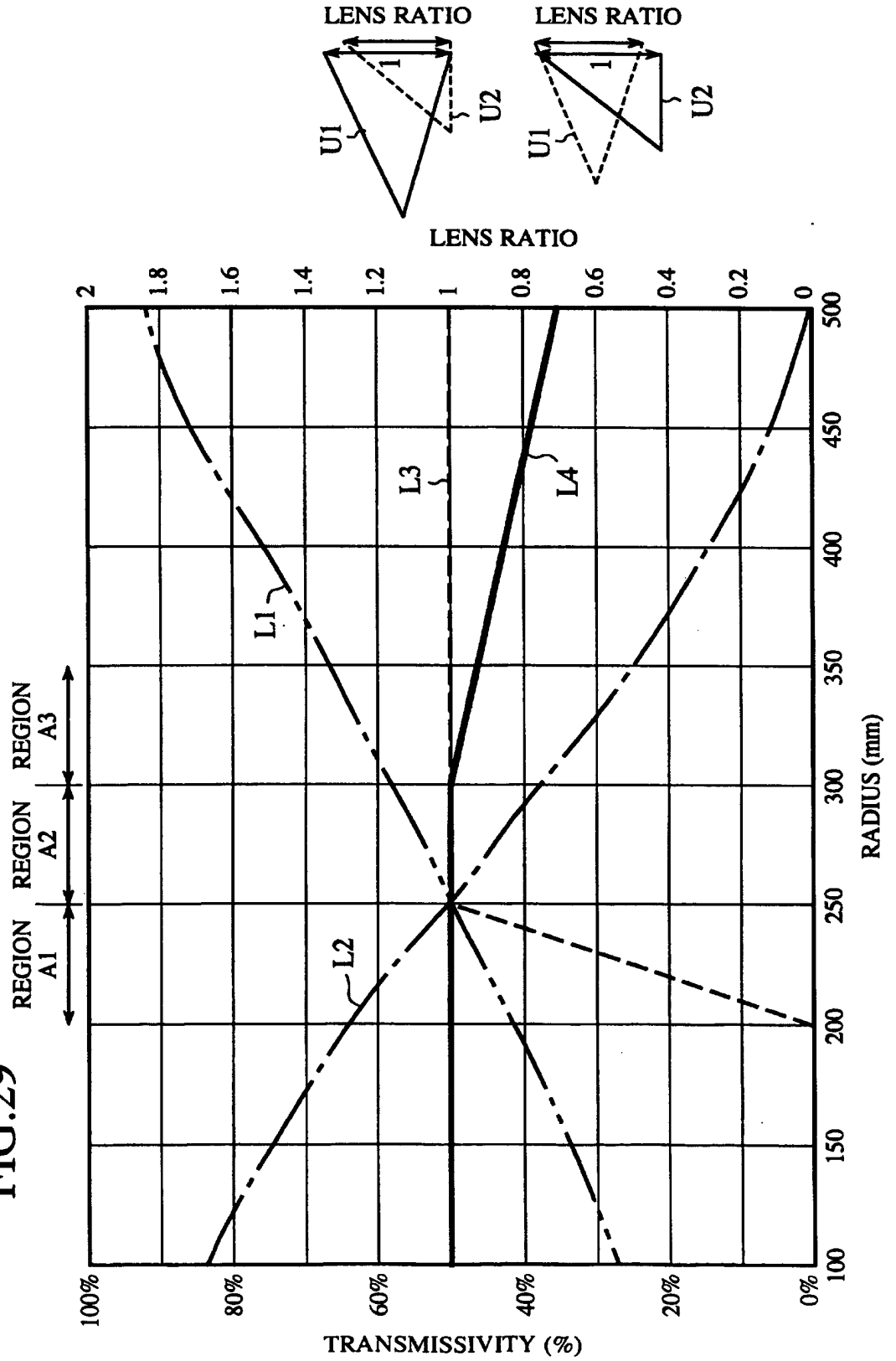


FIG.28B



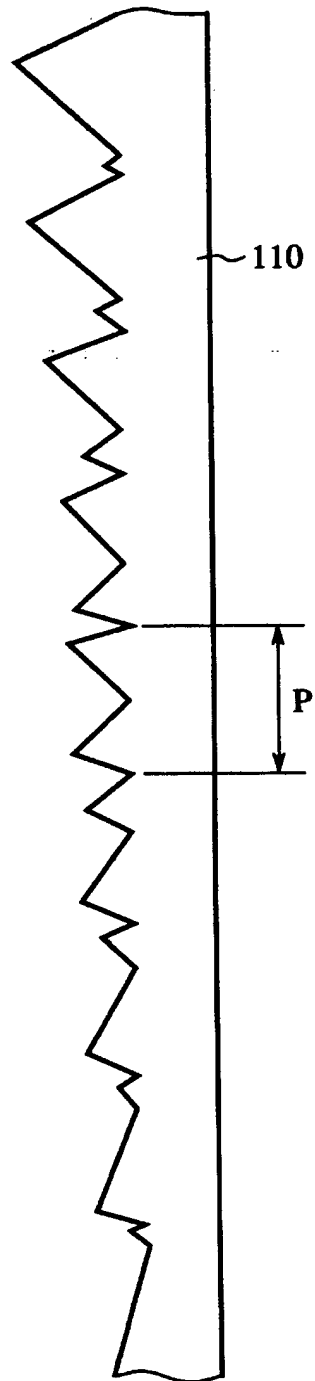
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FIG. 29



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FIG.30



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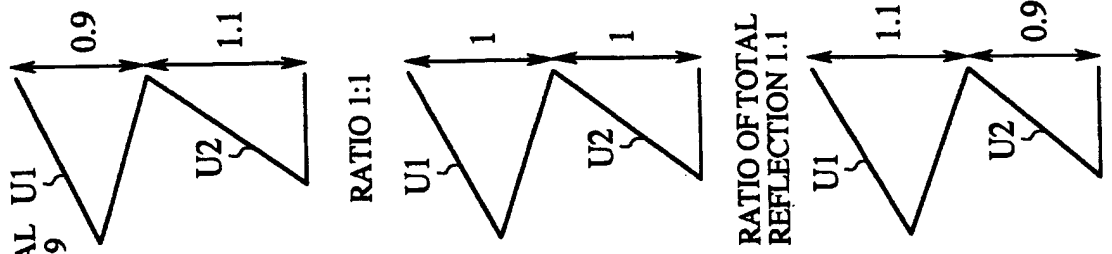
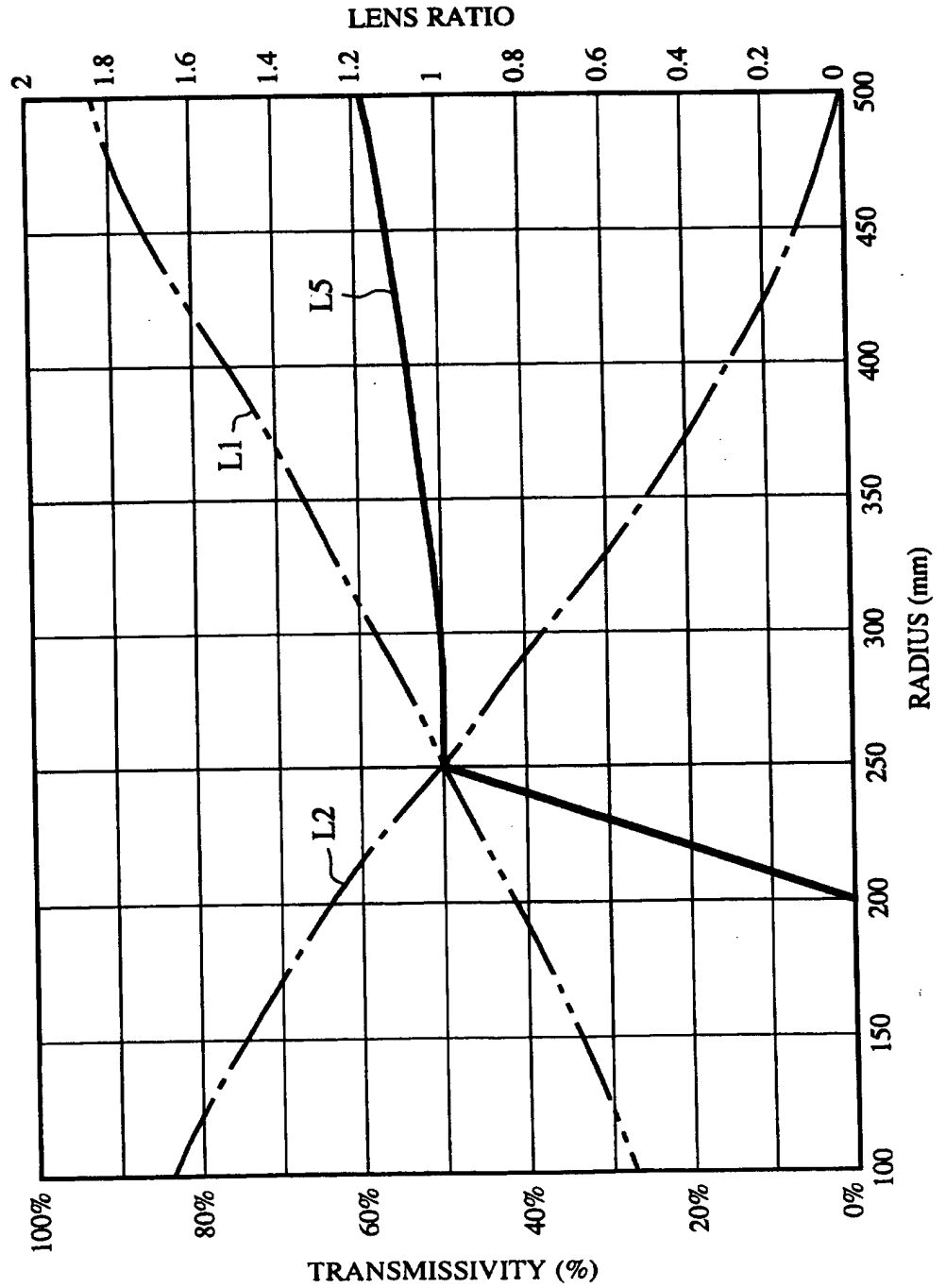
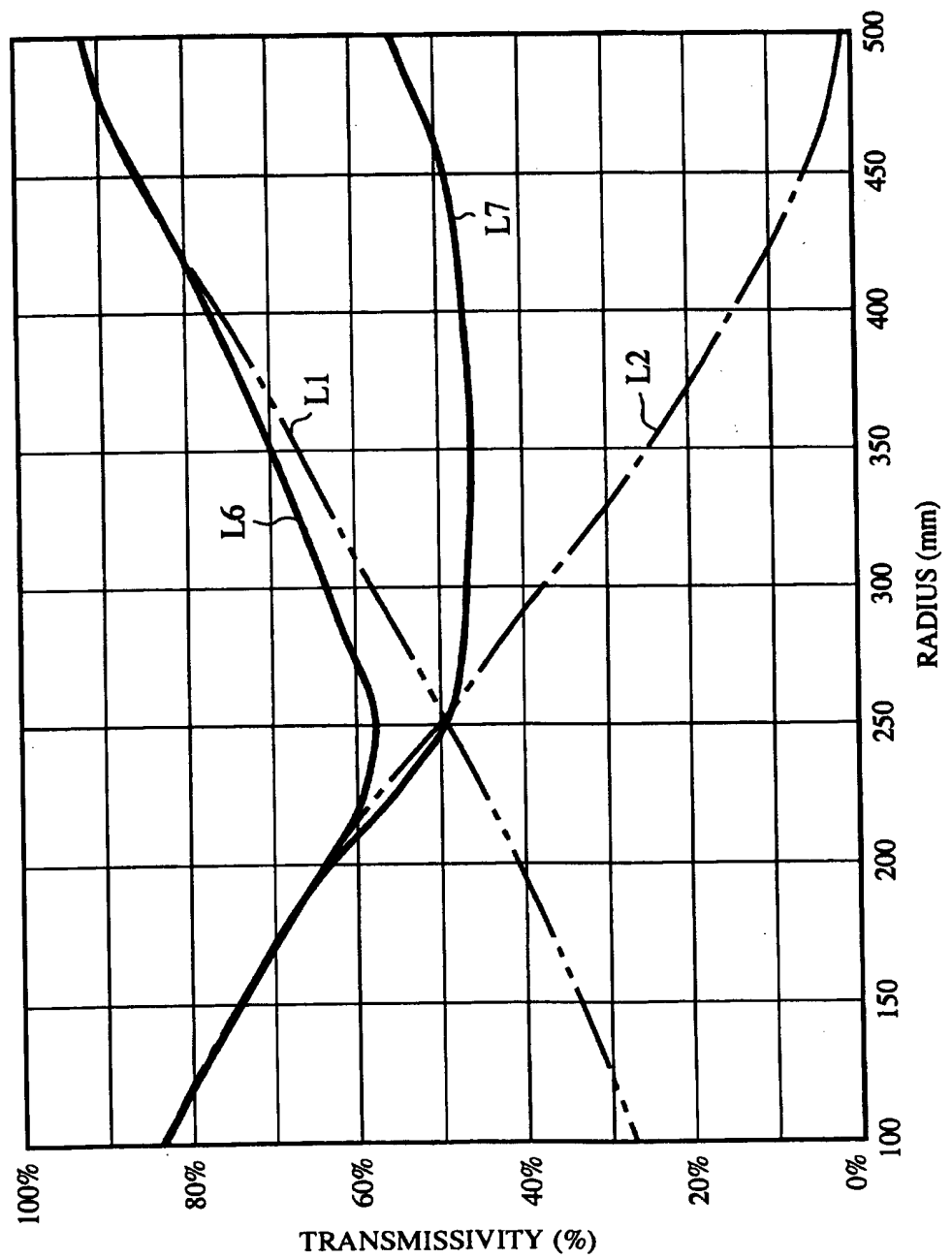


FIG.31

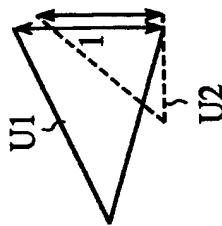


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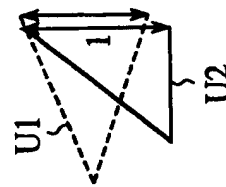
FIG.32



LENS RATIO



LENS RATIO



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FIG.33A

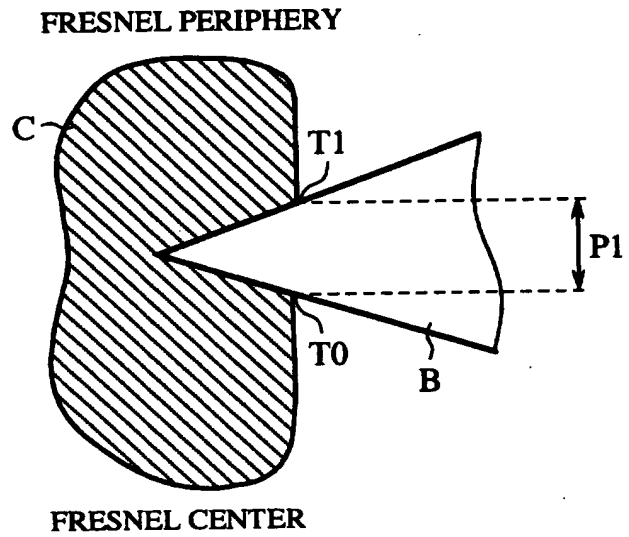
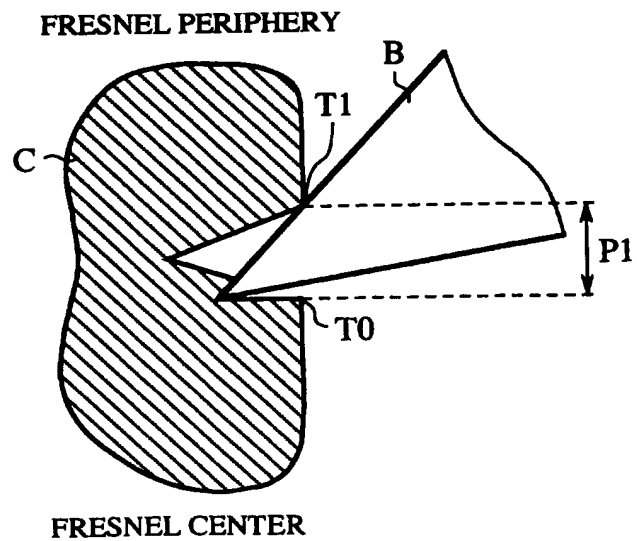


FIG.33B



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FIG.33C

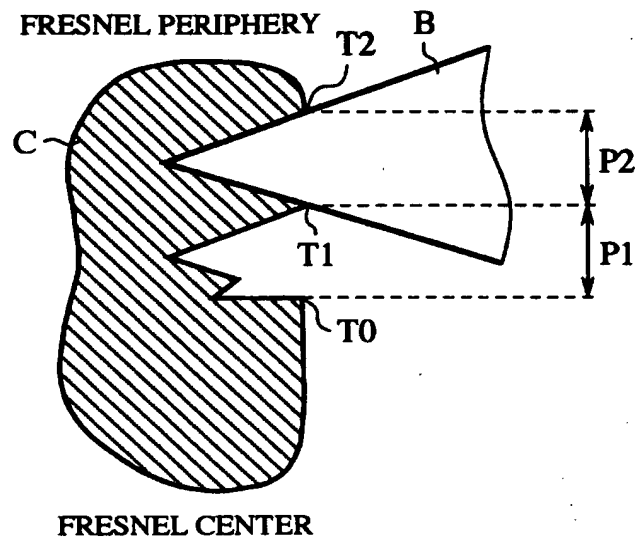
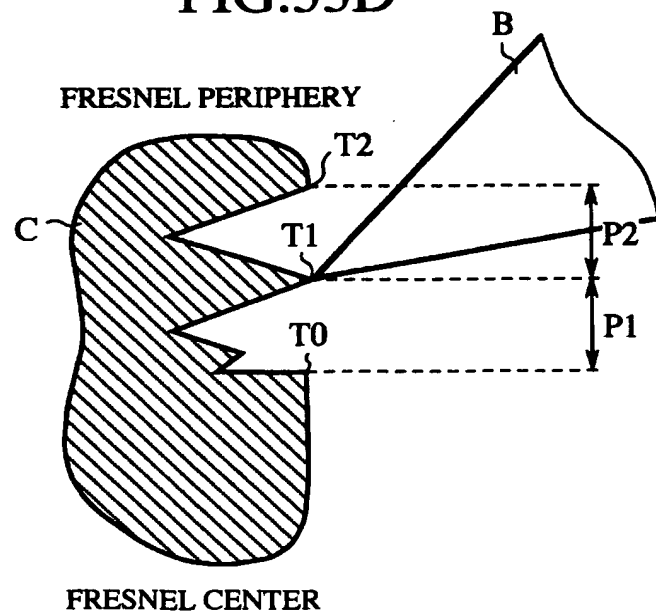


FIG.33D



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FIG.33E

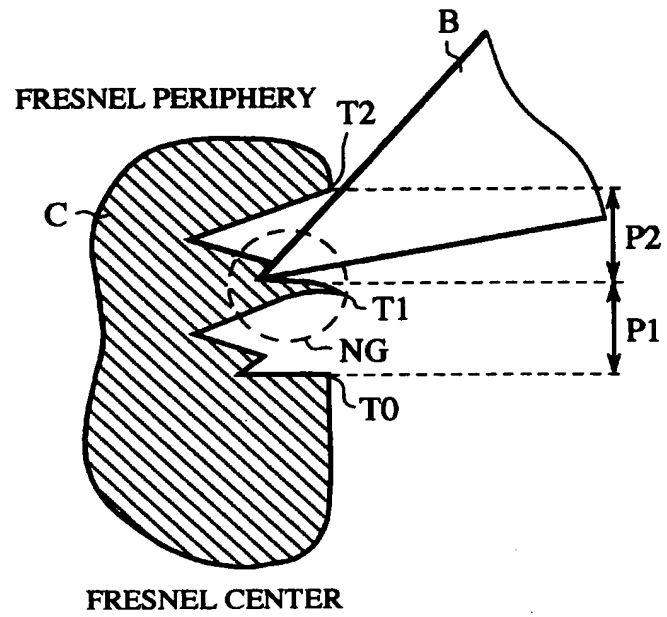
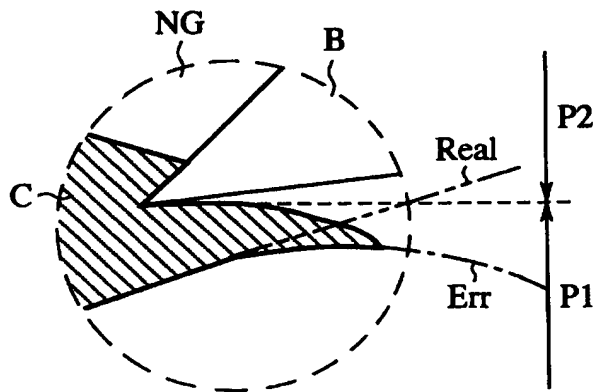
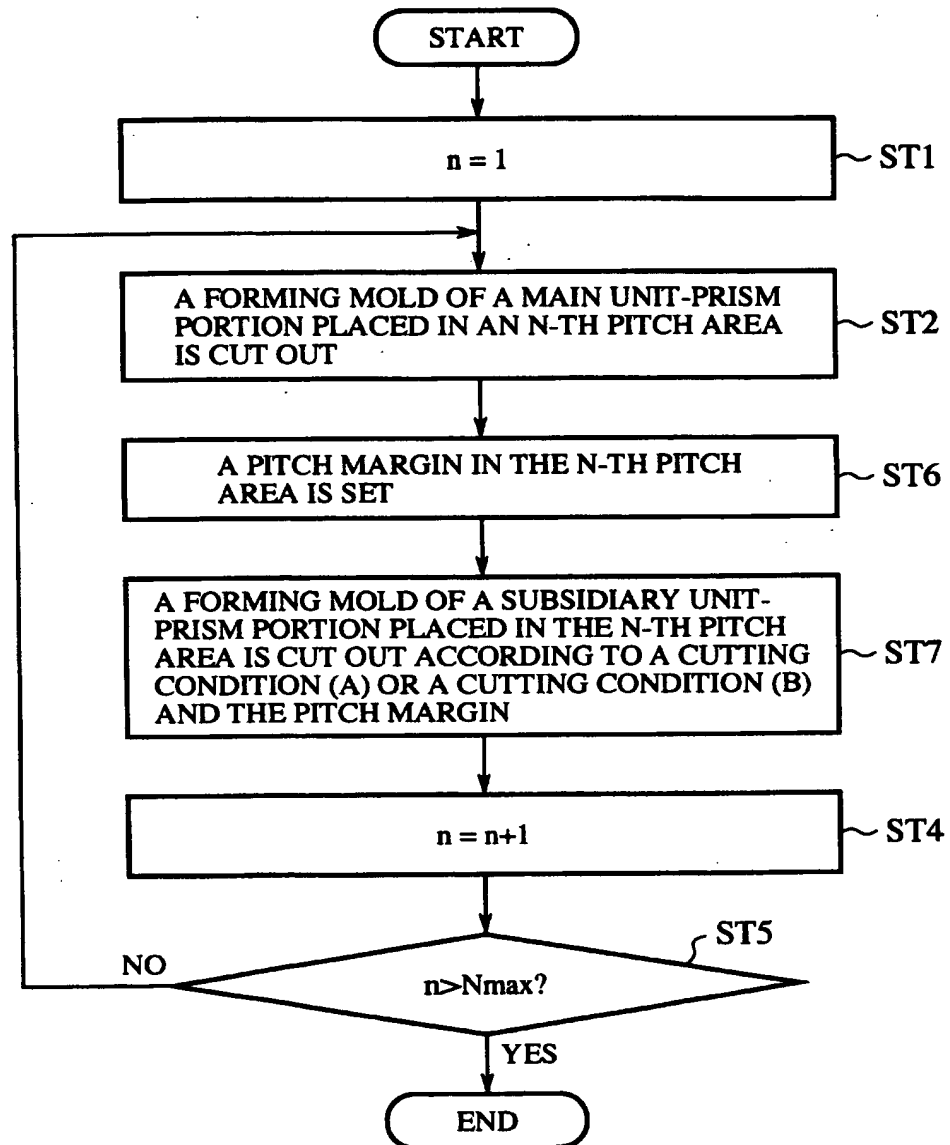


FIG.33F



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FIG.34



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FIG.35A

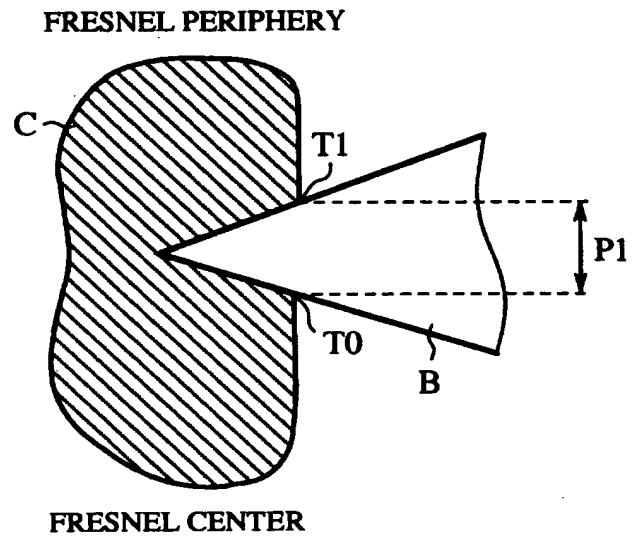
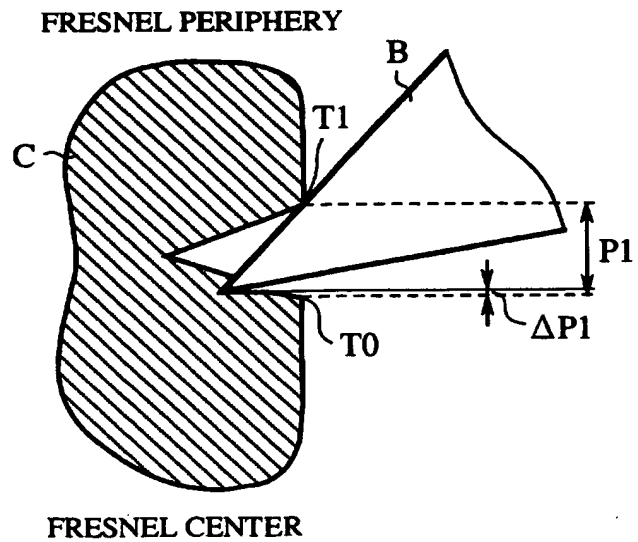


FIG.35B



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FIG.35C

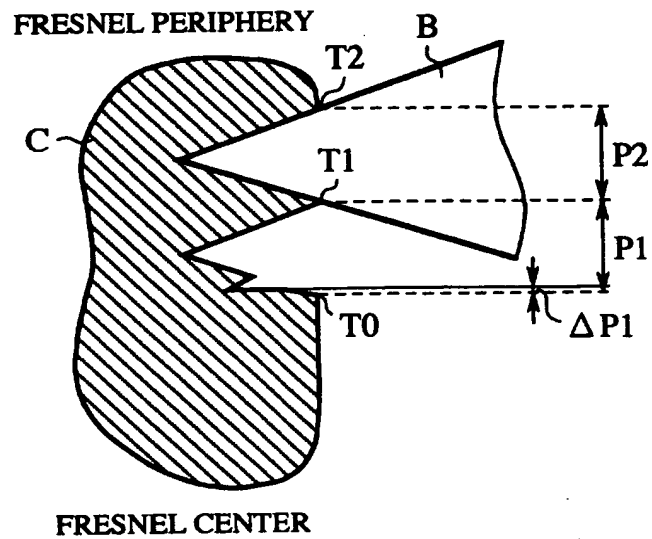
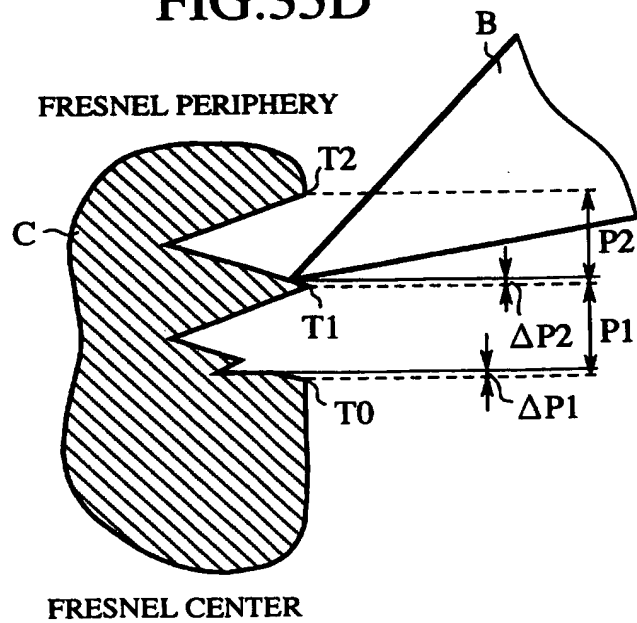


FIG.35D



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FIG.35E

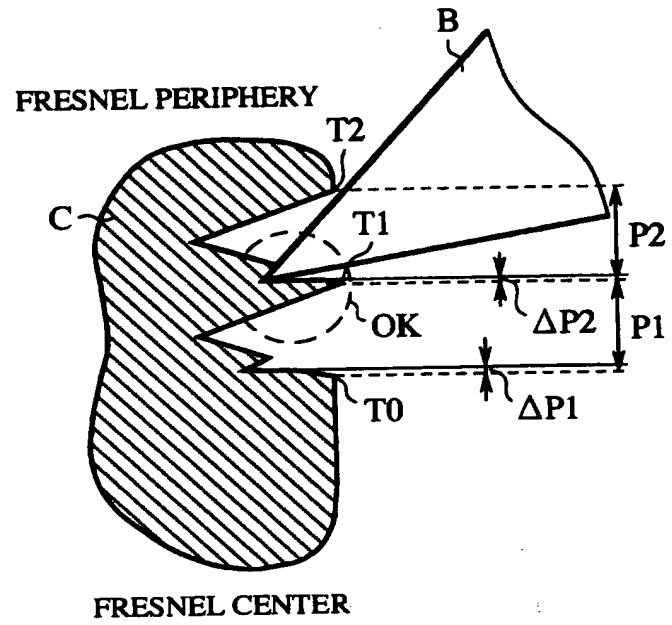
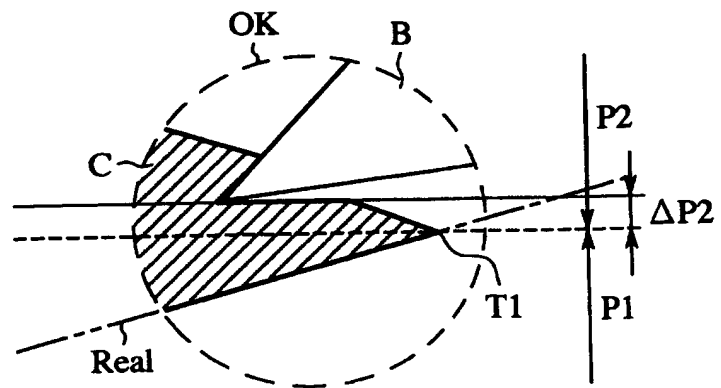


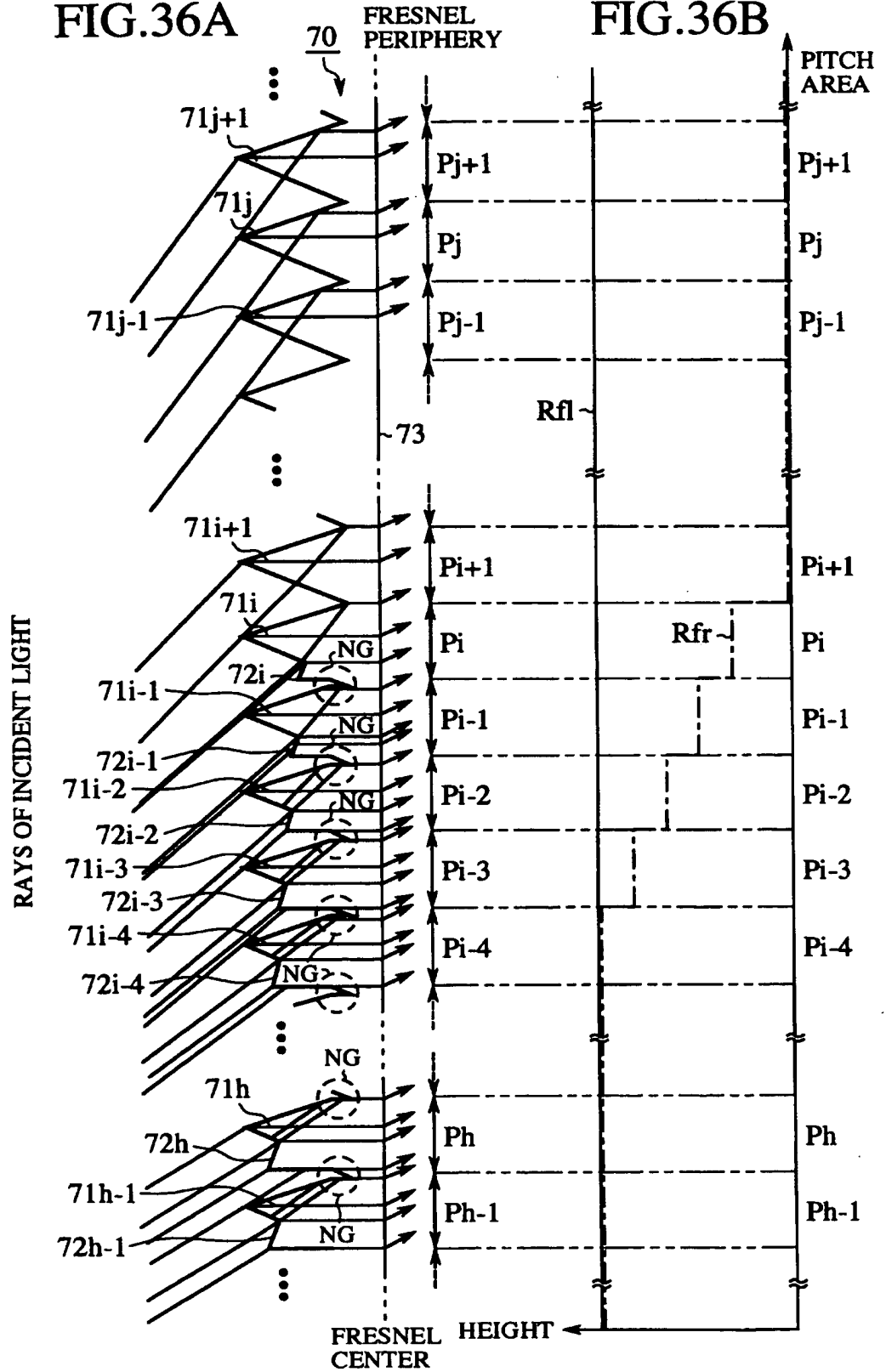
FIG.35F



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FIG.36A

FIG.36B



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FIG.37A

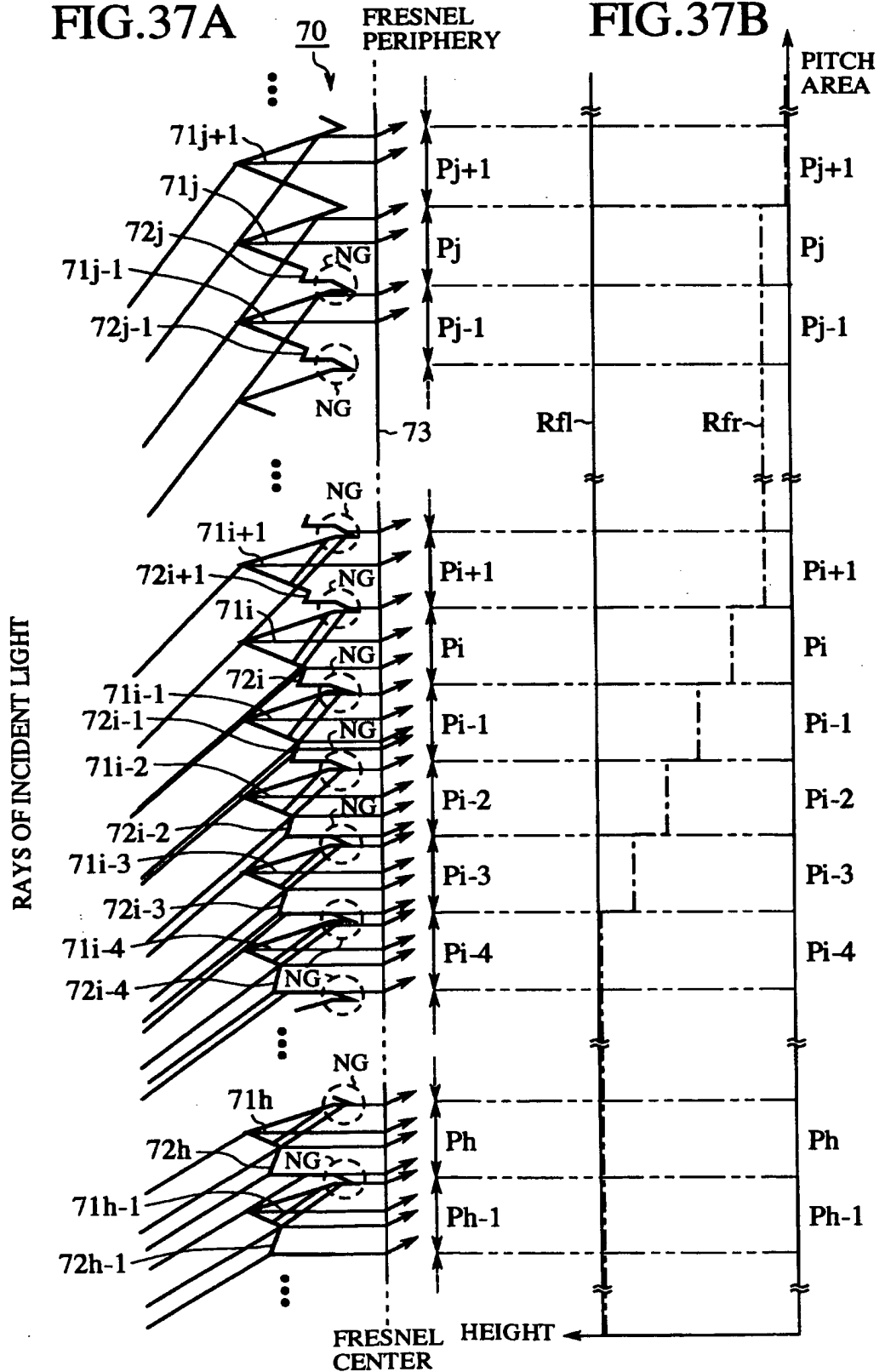


FIG.37B

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FIG.38A

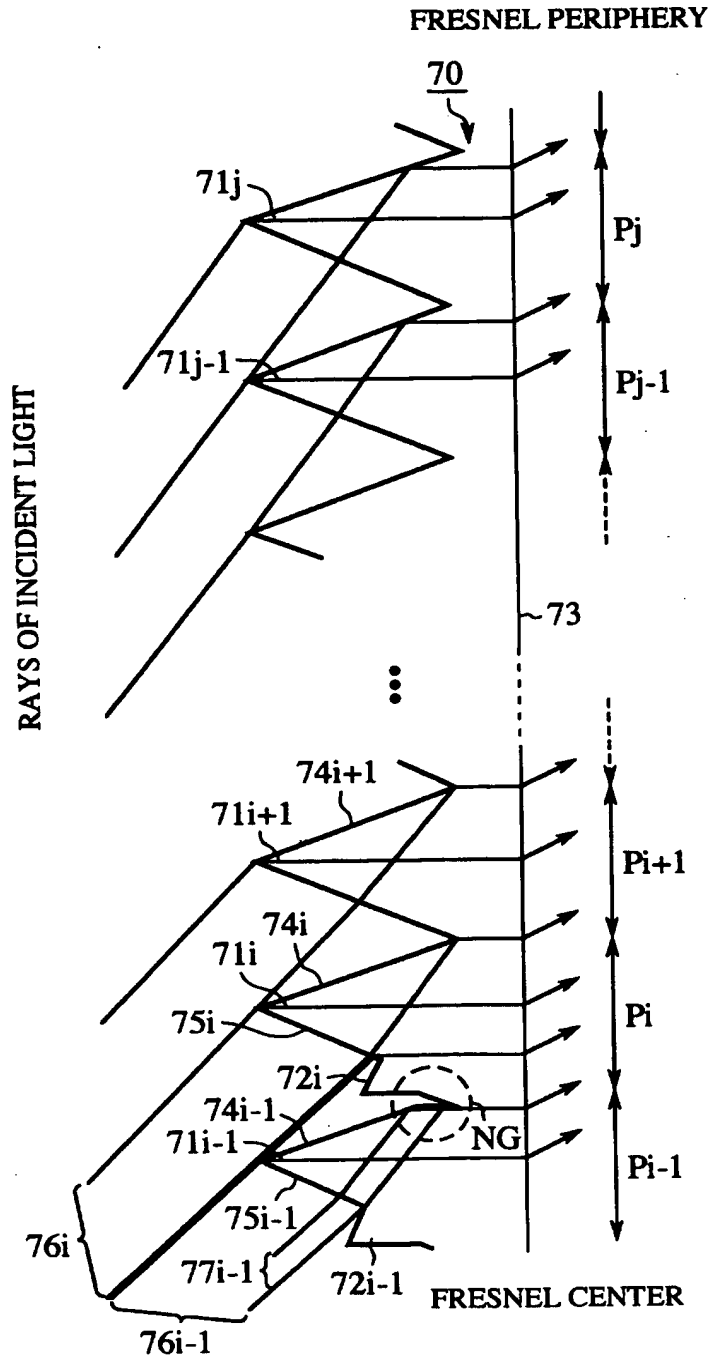


FIG.38B

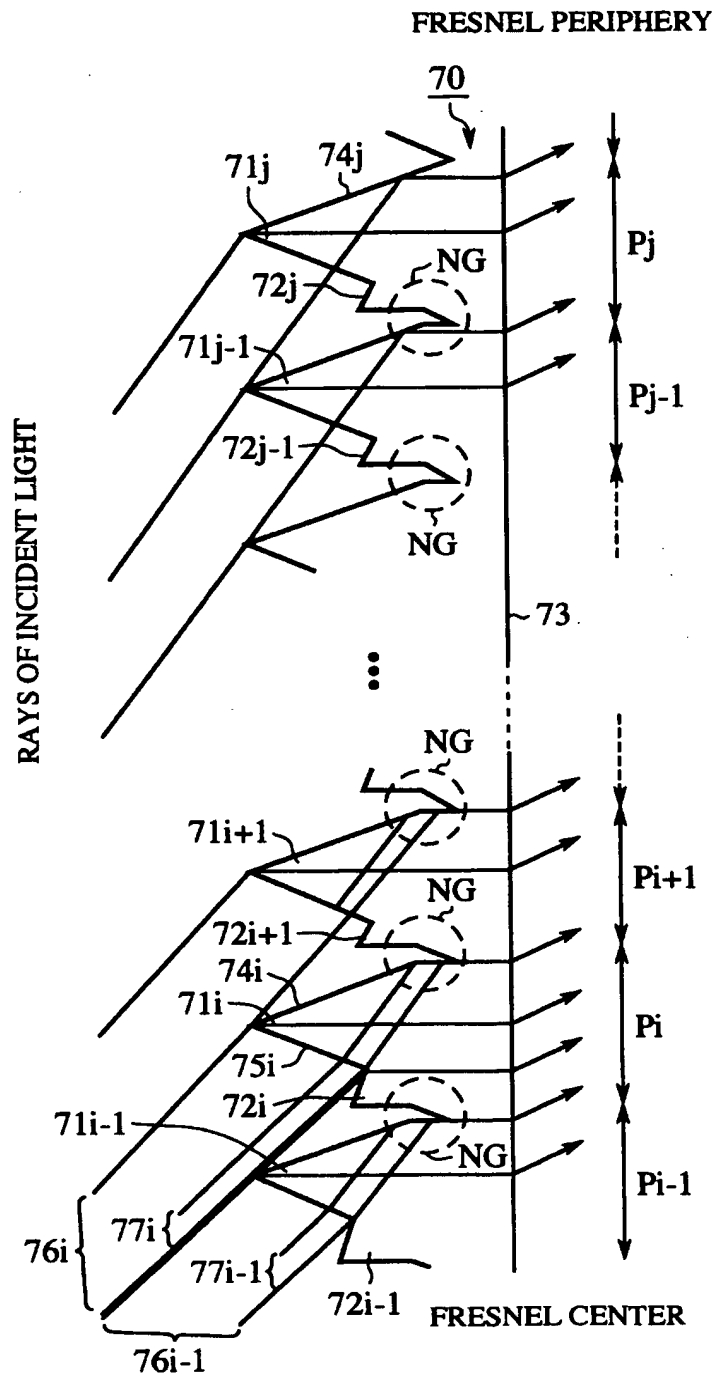
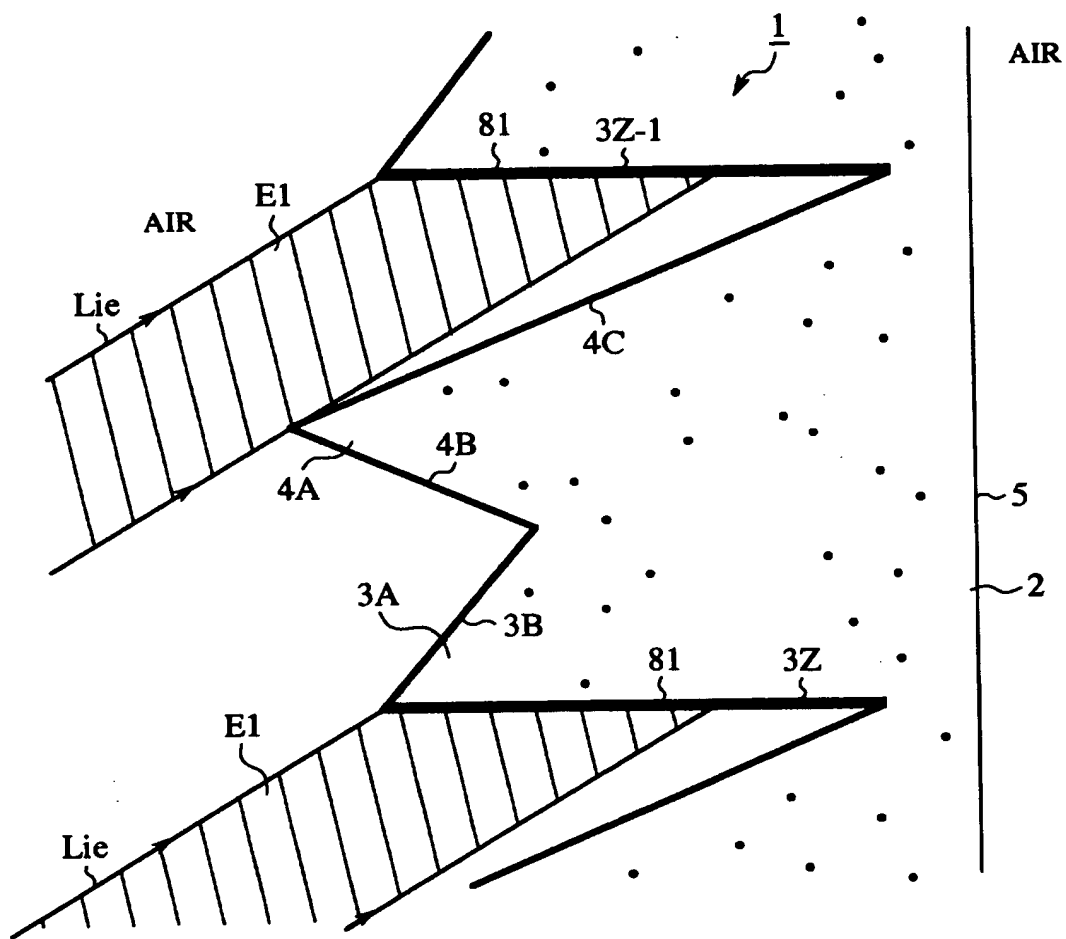


FIG.39



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FIG.41A

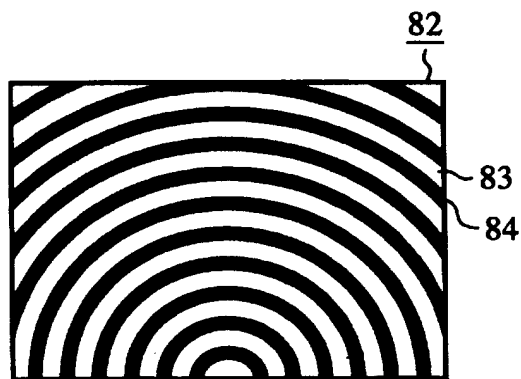
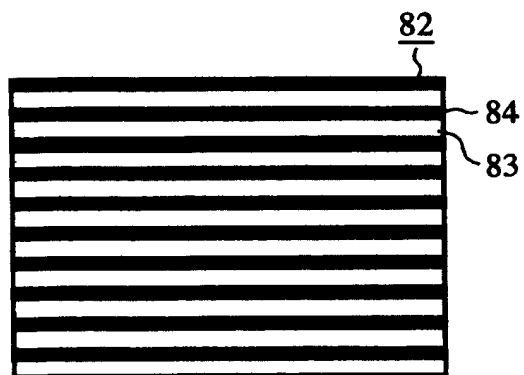


FIG.41B



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FIG.42

